JULY 1946

Public Works

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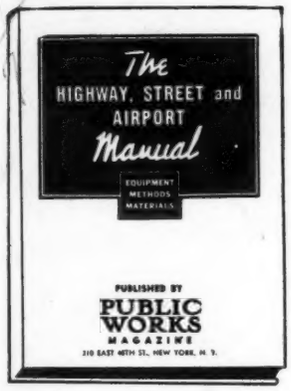
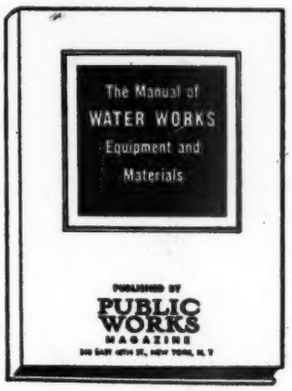
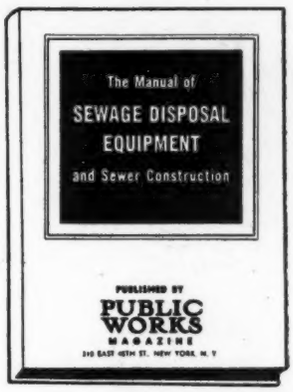
How to Inspect Bridges

Causes of Leakage in a Clay Core-Wall

Infiltration Into Sewers







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THESE three Manuals are the industry's guides to *equipment* and *materials*. Everyone knows that now. So in the future we shall call them by the shorter names given below.

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THE SEWERAGE MANUAL (formerly The Manual of Sewage Disposal Equipment and Sewer Construction).

If you do not have these valuable Manuals on *your* desk—and need the data they contain—ask today how you can get them. PUBLIC WORKS Magazine, 310 E. 45th St., New York 17, N. Y.

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FLEXIBILITY: Swing Diffusers can be raised to the tank walk for tube cleaning and for simple re-arrangement of diffuser tube spacing to conform with oxygen demand without de-watering tank or interrupting operation.

EFFICIENCY: Chicago Wide Band Air Diffusion System provides greater oxygen absorption—eliminates center coring—less air for optimum circulation — power economy through reduced hydrostatic head on elevated diffuser tubes.

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SEWAGE EQUIPMENT DIVISION

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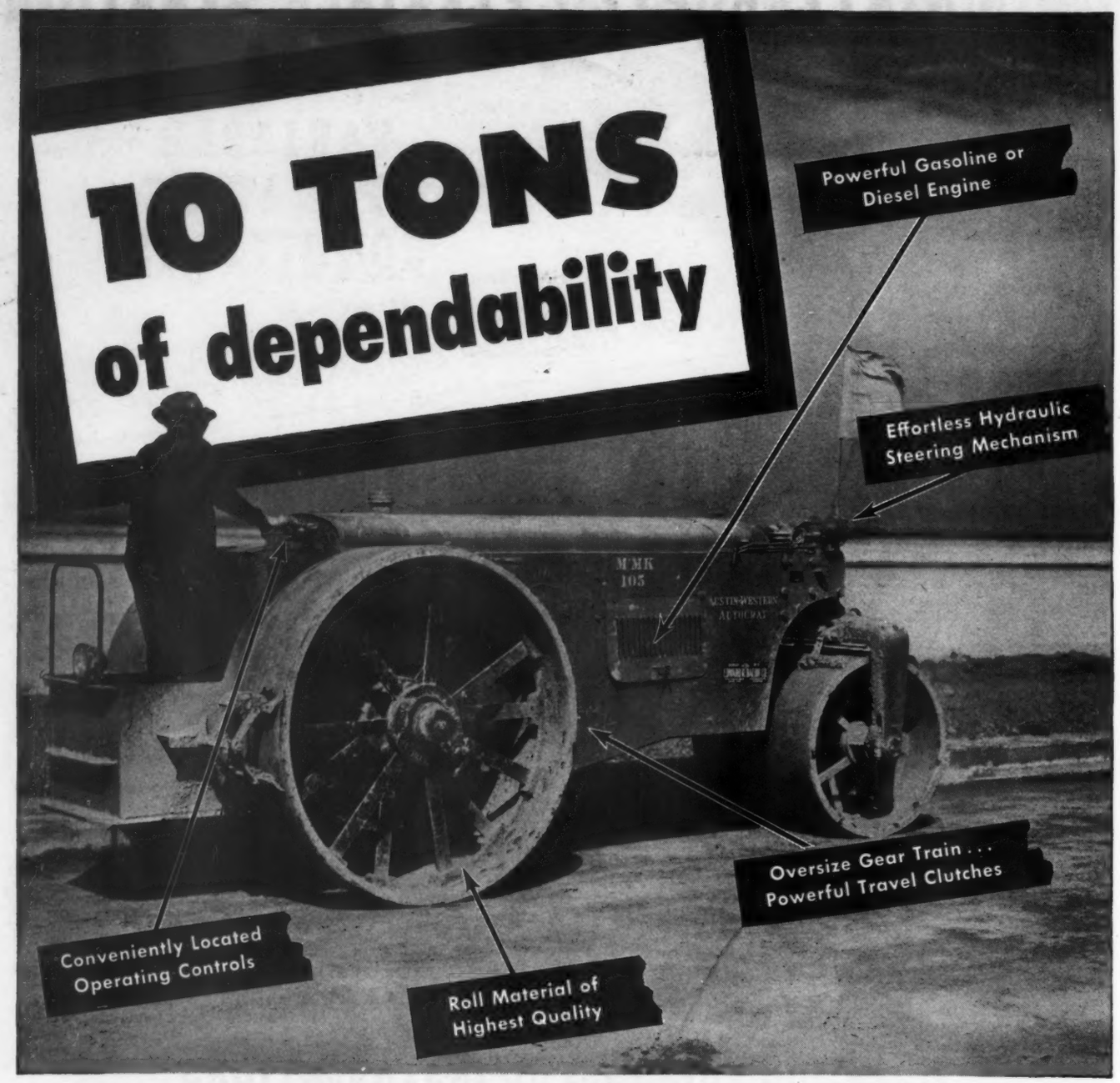
Swing Diffusers, Stationary Diffusers, Mechanical Aerators, Combination Aerator-Clarifiers, Comminutors.

VOL. 77 PUBLIC WORKS No. 7

Entered as second-class matter at the Post Office at New York, N. Y., Sept. 1, 1929, under the Act of March 3, 1879. Published monthly by PUBLIC WORKS JOURNAL CORPORATION, 310 East 45th St., New York 17, N. Y. Subscription Rates: U. S. A. and Possessions, Mexico and Cuba, $3.00; Canada, $3.50. All other countries $4.00

JULY, 1946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of dependability
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When you need special information—consult the classified **READER'S SERVICE DEPT.**, *pages 71-73*

BOOK REVIEWS

Manual for Water Plant Operators. By A. A. Hirsch. Chemical Publishing Co., Inc., New York. 368 pages, 50 illustrations; $6.50.

This publication is an outgrowth of the traveling school for water and sewerage system operators conducted by the Louisiana State Department of Education, of which Mr. Hirsch is an instructor. This book is evidently based on the needs of this traveling school for the preface states that it was intended "to furnish a text for individual study during the intervals between visits and classes"; and that "while the method of presentation has been accommodated to the grasp of men without more than grammar-grade schooling, the contents of this book reach widely into the broad subject matter which a truly competent operator should know."

Aside from the relatively minor fact that the text is weighted on the side of Louisiana conditions, which is to be expected, this should be a valuable book for operators, especially in providing them with background material. It is printed on a good grade of paper and the illustrations are uniformly good, well-drawn, clear and to the point. We consider it a very desirable addition to the library of every man engaged in water purification.

[Reviewed by W. A. Hardenbergh]

Water Treatment and Purification. By William J. Ryan. 2nd Edition. McGraw-Hill Book Co., N. Y. 270 pp., 66 ills., $2.75.

This is an excellent brief text, the greater part of which is general in nature, since it is not possible to give details of every process in a book of this size. Considerable space is devoted to the chemical reactions occurring in water treatment, and this ties in well with the space given to boiler feed-water treatment. The author states that he has devoted a relatively large proportion of the text "to boiler feed-water because this department of water treatment is of interest to perhaps the largest group of engineers and because of the complexities of the subject."

In this book, 38 pages are allotted to lime and soda-ash treatment, 26 pages to ion exchangers, 14 pages to general consideration of boiler feed-water treatment, 48 pages to the methods used for such treatment, and 16 pages to prevention of corrosion. In all, these subjects occupy about half of the text.

The lists of articles at the end of the various chapters do not seem to have been brought fully up to date in this second edition.

(Reviewed by W. A. Hardenbergh)

PUBLIC WORKS

Founded in 1896

Devoted to the interests of the engineers and technical officials of cities, counties and states

Vol. 77 No. 7

W. A. HARDENBERGH and A. PRESCOTT FOLWELL
Editors

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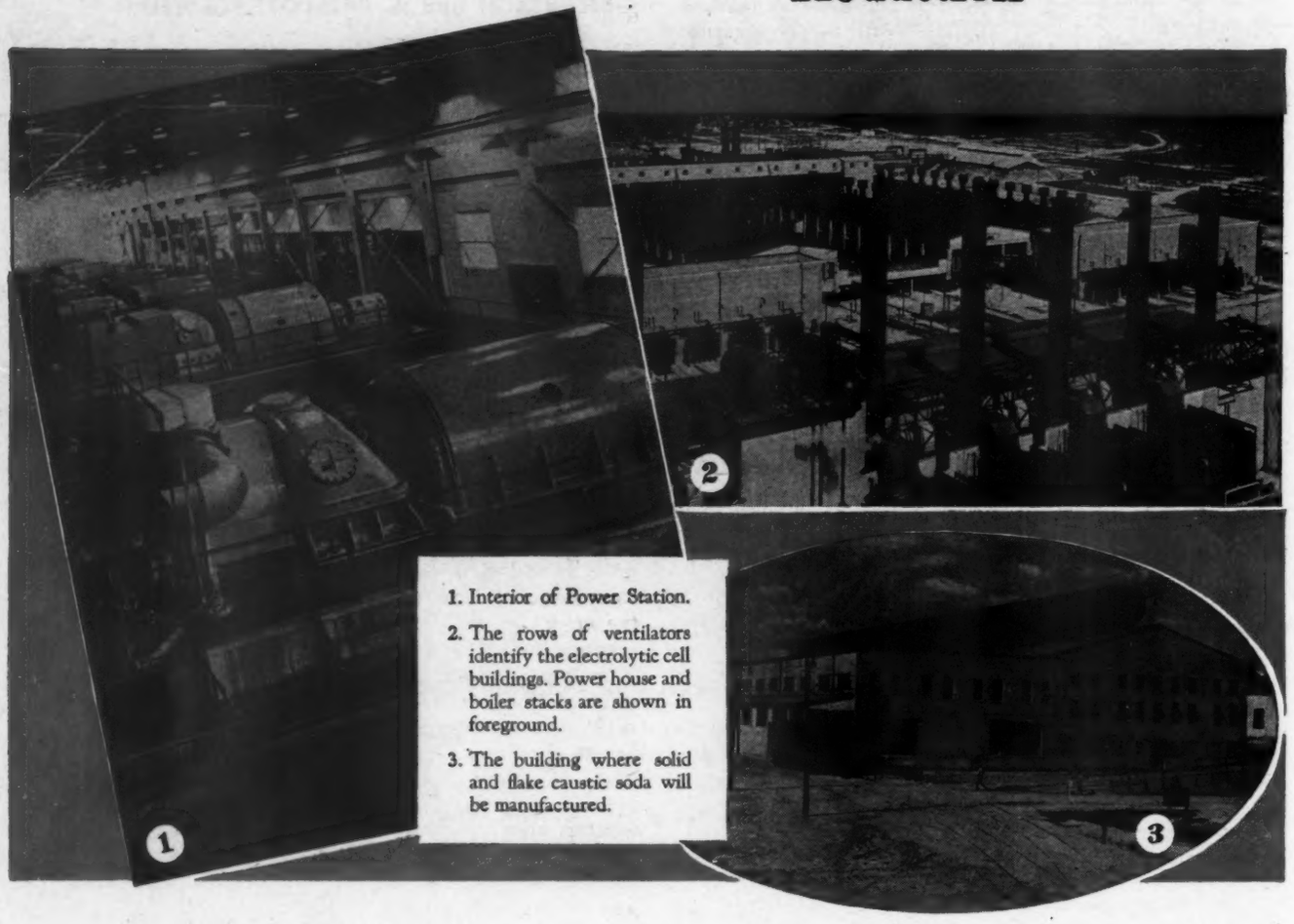
Published monthly by PUBLIC WORKS JOURNAL CORPORATION

Editorial and advertising offices: 310 East 45th St., New York 17, N. Y.

J. T. MORRIS, *President;* W. A. HARDENBERGH, *Vice-President;* CROXTON MORRIS, *Treasurer;* A. PRESCOTT FOLWELL, *Secretary. Advertising representatives:* New York: ARTHUR K. AKERS, *Advertising Manager;* Chicago: LEWIS C. MORRIS, 612 No. Michigan Ave., Chicago 11, Ill. SUBSCRIPTION RATES: U.S.A. and Possessions, Mexico and Cuba, $3.00; Canada, $3.50. All other countries, $4.00. Single copies, 35 cents each except issues containing book-length texts, which are $1.00 apiece.

Lake Charles Plant will increase *Caustic Soda—Chlorine* Production



1. Interior of Power Station.
2. The rows of ventilators identify the electrolytic cell buildings. Power house and boiler stacks are shown in foreground.
3. The building where solid and flake caustic soda will be manufactured.

Built to make wartime magnesium, "Lake Charles" is being converted to the manufacture of chlorine and caustic soda. While actual production will not start until some time next year, the existence of certain vital facilities permits an earlier start than would be possible by constructing an entirely new plant. "Lake Charles" will be operated by The Southern Alkali Corporation—a Pittsburgh Plate Glass Company affiliate. Located in Louisiana, this plant adds an important link to a cross-the-country group of facilities, all strategically located to serve industry efficiently and economically. This group includes a Texas Plant at Corpus Christi—owned by The Southern Alkali Corporation—and Columbia plants at Barberton, Ohio, Natrium, W. Va., and Owens Lake, Calif.

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PITTSBURGH PLATE GLASS COMPANY

COLUMBIA CHEMICAL DIVISION

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When you need special information—consult the classified READER'S SERVICE DEPT., *pages 71-73*

The Editor's Page

Looking Ahead on Housing and Public Works Construction

Many of our readers know at first hand a lot about the need for more and better housing. A good many homes are being built; more are planned for early construction. While we are waiting for these to become realities, let us look at what they will mean in terms of public works construction. For this purpose, we may assume a million new homes; and we can further assume on a very conservative basis that each new house will occupy at least 150 ft. of frontage, including all cross street areas, vacant lots and distances between built-up sections.

As a starter, this gives us 75 million feet of sewer lines, 75 million feet of water pipes, 50 million feet of sewer connections, and 50 million feet of water services; based on common usage, there will be 13,000 valves and 5,000 hydrants; if 50% of the services are metered, which is the nation-wide average, half a million meters will be used. With a 40-ft. wide pavement, there will be 33 million square yards of surfacing to be placed, 150 million feet of curbs, and 150 million feet of sidewalks. Some 15,000 miles of refuse collections routes must be provided once or twice a week, according to frequency of collection service. Probably there will be be at least 10,000 more miles of snow plowing after each storm.

Jointing materials, tanks, reservoirs and pumping stations, for both water and sewage will be needed. There will be some increased demand for water even though all of these folks merely move out from living with their in-laws, because water use in a house is not wholly dependent upon the number of people in it. Actually, many new homes will be located in areas necessitating material enlargement of existing facilities. There will be more sewerage, and many treatment plants will have to be enlarged. Even if new increments of population are disregarded, we may expect these extended sewers to contribute at least 5,000 gallons of infiltration per mile per day, or 75 mgd.

Actually, this housing program and the consequent shift of population cannot be measured fully in advance. The speculations above are probably altogether too conservative. All we can really say is that it is full time that we got mentally ready for a lot of work that perhaps many of us had not thought a lot about before.

Sanitary Engineering in the Post-War Army

Plans for sanitary engineering in the post-war army do not take into account the lessons learned during the war, nor do they recognize the outstanding contributions made by sanitary engineers in protecting the health of the troops. Without the services of sanitary engineers in water supply and water quality control, waste disposal and mosquito and malaria control the sickness record of the army would not have been "the lowest that any army ever had in any war."

Existing plans for utilizing sanitary engineers in the post-war army have been made solely by regular army medical officers. These plans are in direct disagreement with the recommendations of such well-known and experienced sanitary engineers as Abel Wolman, Gordon Fair, and Harold Whittaker, and of the war-time director of the Sanitary Engineering Division. So far as is known, the proposed plans have not had the approval of any of the leaders in the field: they are in disagreement with the recommendations of the medical officers who had charge of preventive medicine activities in the army; and they are unfair and discriminatory.

When the army reorganization bill comes before Congress, these unfair and inadequate plans ought to be vigorously combated by every engineering organization and by every engineer. This magazine will try to give adequate notice to its readers so that they can contact their congressmen and senators in the interest of a fair deal for engineers.

Pot-Holes and Post-War Facts

Riding the ordinarily excellent roads of a neighboring state, we ran into our war-time friend, the pothole. It seems that the State Highway Department is plagued with labor shortages, due largely to the higher wage scale of private employers, but also because there is not an adequate supply of labor available.

What is the remedy for these labor shortages in the state, county and municipal fields? The real answer, like many other obvious things, is too often overlooked. Is it not a greatly increased attention to mechanization? For years, in a vague and generalized way, we have agreed that machinery was better than men for most standardized operations, and especially better for the *other fellow*; we have pretty much gone on using manpower ourselves, maybe because it was a habit. Now we lack men and the work to be done is mountainous. Nor can we look forward to any time in the near future when labor will be cheap and plentiful again. For many years to come, our governmental units are faced with stiff and probably losing competition for manpower. Right now is the time for them to start thinking and investigating: What processes can be mechanized; what equipment is available—not only as a way out but also as a better and more efficient way to get work done.

We thoroughly believe that many engineers and officials will be amazed at how many things they have continued to do the hard way in the past, and the less efficient and more costly way; they will be surprised to learn what is available right now in the line of machinery that will do quicker, better and cheaper work. And equipment that will be still more advantageous and economical is past the drawing-board stage in manufacturers' plants all over the country. For their own good, engineers and officials should watch more closely than ever before what manufacturers have to offer. If you don't see what you need, let us help you.

No county, city or state can afford to wait indefinitely to do work that needs to be done now. Money is generally available and materials soon will be. If nothing is done, one of two things will happen: There will be a new set of officials, or the community will slip back in comparison with other communities. No official wants the first to happen, and no community desires the second. It is a time, if there ever was one, when we need new and confident aggressiveness, courage and leadership.

You don't have to handle a rugged product, such as cast iron pipe, with kid gloves. However, use reasonable care in unloading, distributing and lowering it into the trench, and you give cast iron pipe a good start on the century or more of useful life cast into it at the foundry. A level trench bottom, without humps or hollows, and a tamped backfill (in all but sandy soils) are also important. Under normal conditions, cast iron pipe, so laid, need never see daylight again for centuries. But if population shifts require re-routing, or replacing with larger pipe, you can take up the original line, sell it or re-use it elsewhere. Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 S. Michigan Ave., Chicago 3.

CAST IRON PIPE
SERVES FOR CENTURIES

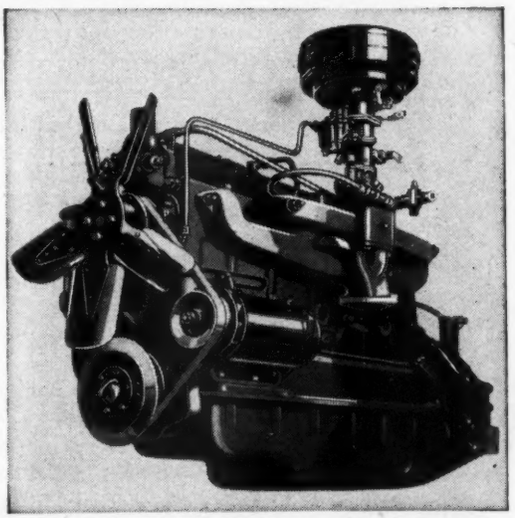
When you need special information—consult the classified READER'S SERVICE DEPT., *pages 71-73*

Ask G.I. Joe about GMC RUGGED LONG LIFE

Returning Service Men regard GMC army trucks as the most rugged transport vehicles of the war. In GMC's fine war record there is plenty of reason for this belief.

GMCs of one Quartermaster Company rolled up a million miles . . . through the Pacific's swampy jungles, blinding dust and destructive tropical humidity . . . without one man-day lost due to motor mishap. GMCs stormed over the roads of Normandy, bumper to bumper, to help haul the 500,000 tons of supplies transported by the famous Red Ball Express. Other GMCs pulled tremendous loads over the mountains of Italy, the sands of Africa, the frozen tundras of Alaska.

You can look for similar rugged reliability in the GMC you buy for commercial use. For every GMC civilian model from ½ to 20 tons has the same basic engine design as that which powered nearly 600,000 war-proved GMC trucks and "Ducks."



The famous "270" engine, power plant of the "Army's Workhorse," also powers GMC models in the 3-ton range. All other GMC gasoline engines are of the same basic, war-proved design.

THE TRUCK OF VALUE

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CLAY PIPE ELIMINATES SEWER GAS DAMAGE at lowest cost • per • year

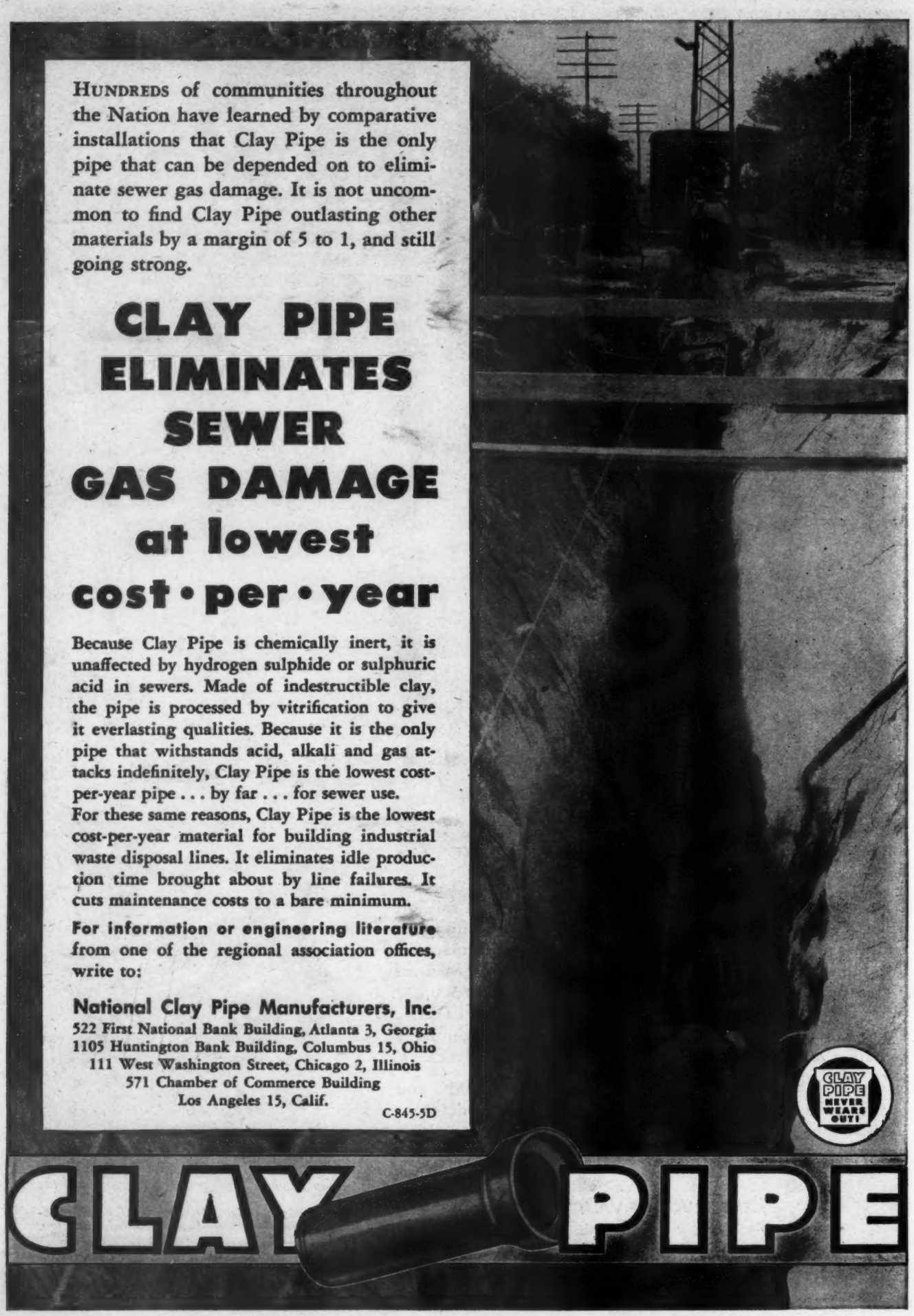
Because Clay Pipe is chemically inert, it is unaffected by hydrogen sulphide or sulphuric acid in sewers. Made of indestructible clay, the pipe is processed by vitrification to give it everlasting qualities. Because it is the only pipe that withstands acid, alkali and gas attacks indefinitely, Clay Pipe is the lowest cost-per-year pipe . . . by far . . . for sewer use.

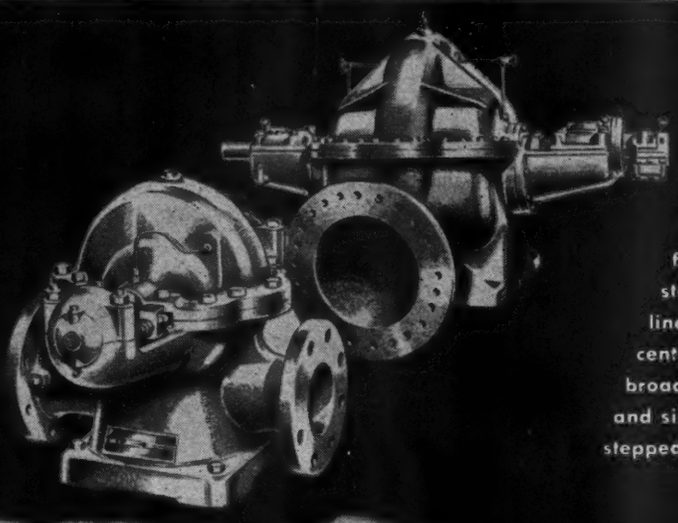
For these same reasons, Clay Pipe is the lowest cost-per-year material for building industrial waste disposal lines. It eliminates idle production time brought about by line failures. It cuts maintenance costs to a bare minimum.

For information or engineering literature from one of the regional association offices, write to:

National Clay Pipe Manufacturers, Inc.
522 First National Bank Building, Atlanta 3, Georgia
1105 Huntington Bank Building, Columbus 15, Ohio
111 West Washington Street, Chicago 2, Illinois
571 Chamber of Commerce Building
Los Angeles 15, Calif.

C-845-5D

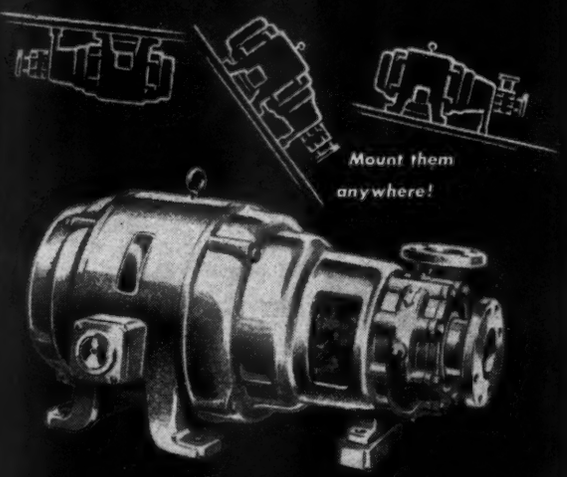




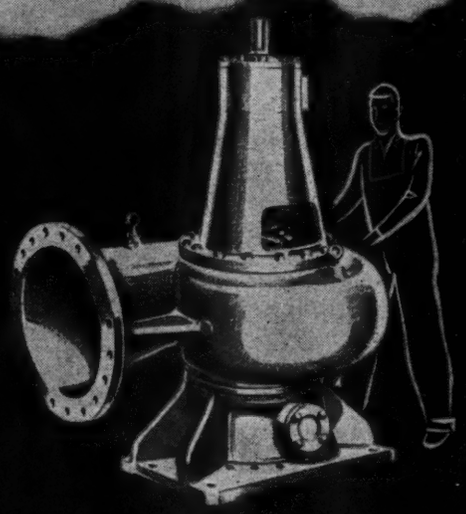
The older they are the farther they fall in attempting to meet standards that are being set by the line of Fairbanks-Morse split-case centrifugal pumps. Here's a line that's broad enough to include the type and size which most closely meets your stepped-up needs.

Time to Forget . . . and Remember!

Now is the time to forget your old pumps whose efficiency is that of a bygone era and whose daily services are costing you money! Remember—pumps are commonly designed and built to answer specific conditions of head and capacity: When these conditions change, the increase in pumping costs may be appreciable.



Replace tired-out, hard-to-get-at pumps with Fairbanks-Morse Builtogether pumps—packaged units, with pump and motor on a single shaft. Used industry-wide, they move up to 1200 gallons per minute at heads up to 260 feet.



Three famous names — Fairbanks-Morse, Pomona and Westco are gilt-edged evidence that when you see your Fairbanks-Morse dealer or call at your Fairbanks-Morse branch office, you're taking the right step toward lowest liquid-moving costs.

Name your pumping job — there's a modern Fairbanks-Morse "high-efficiency" pump ready to handle it. For instance, the line of vertical Angle-Flow pumps for moving lots of water—up to 80,000 g.p.m.—at a cost that, even compared with modern standards, is extremely low.

FAIRBANKS-MORSE

A name worth remembering

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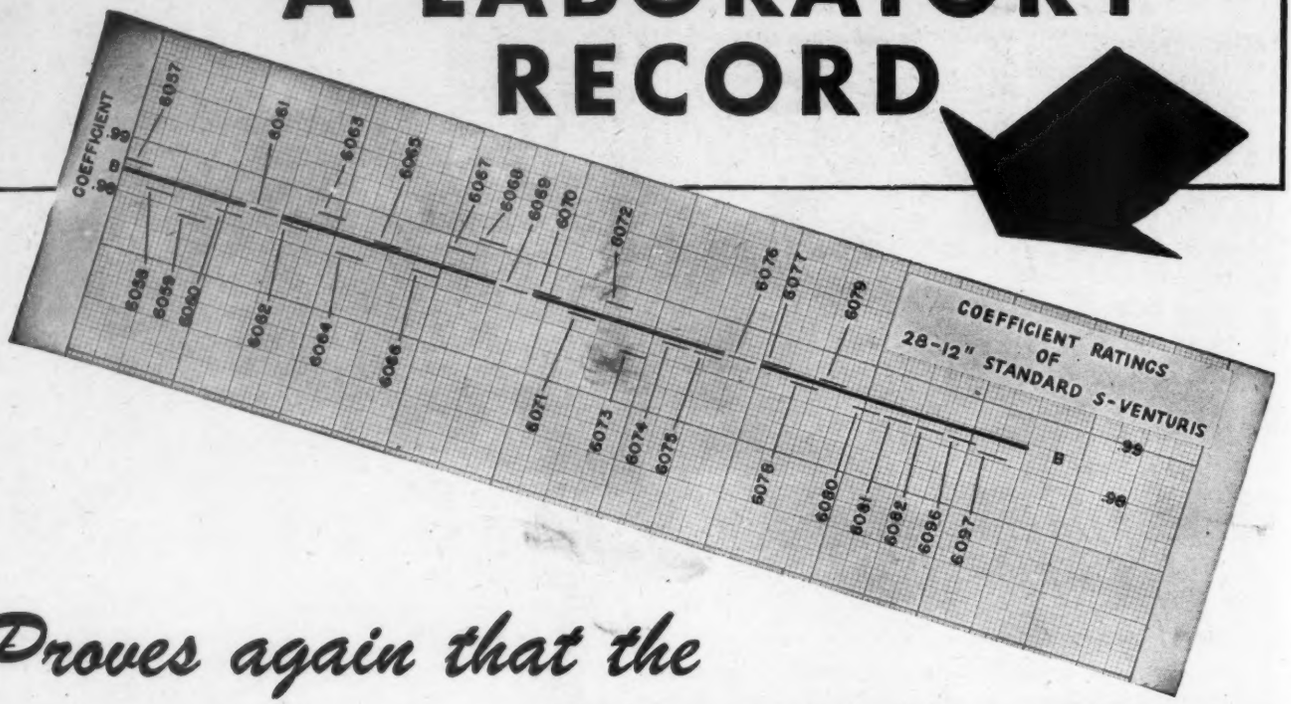
SCALES · STOKERS · RAILROAD MOTOR CARS and STANDPIPES · FARM EQUIPMENT

A LABORATORY RECORD



Proves again that the

SIMPLEX VENTURI TUBE

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Actual weighed water ratings of 28 SIMPLEX Standard Form VENTURI TUBES for the measurement of air, show an arithmetical average of 0.9837, or an average deviation from the 0.9840 coefficient calculated for the design of only 0.03%.

Examine this chart carefully. B-B is the value (.984) of the SIMPLEX Venturi Tube Coefficient as calculated for the particular design of tube. The short lines near B-B are taken from the flat part of the coefficient curves of the 28 numbered Venturi Tubes.

Note the remarkably slight variations shown by the records of the 28 Venturi Tubes tested.

24 tubes within 0.3% (±) of the 0.984 value.
1 tube within 0.7%(+).
2 tubes within 0.5%(—).
1 tube within 0.4%(+).

Here is actual proof of the unsurpassed accuracy and dependability of the SIMPLEX VENTURI TUBE. Here is graphic evidence of the 45 years of experience in research and manufacture that makes such SIMPLEX records possible.

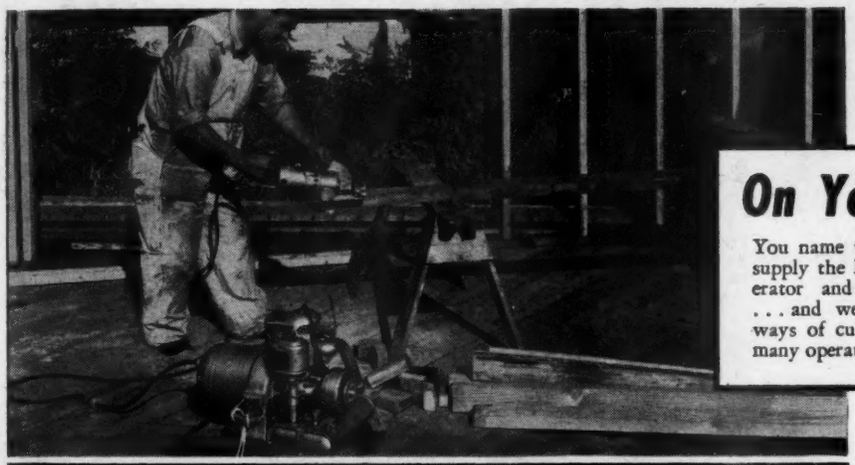
Write for Bulletin 300, describing SIMPLEX MO METERS and VENTURI TUBES.

SIMPLEX VALVE AND METER CO.

6725 UPLAND STREET, PHILADELPHIA 42, PA.

When you need special information—consult the classified **READER'S SERVICE DEPT.,** *pages 71-73*

Step Right Up and Try Them Yourself



On Your Job

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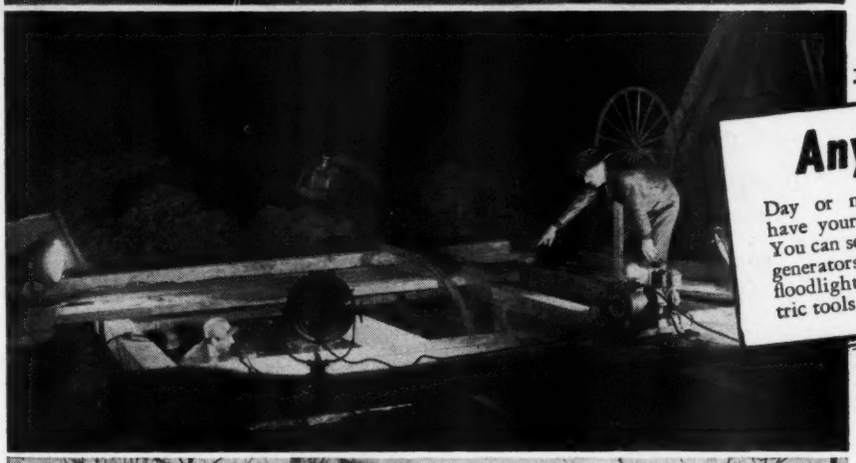

Anytime

Day or night, you can have your demonstration. You can see how Homelite generators operate brilliant floodlights as well as electric tools.

Any Place

We'll go any place. We have representatives covering the entire country . . . men who will demonstrate all our equipment, our self-priming portable pumps, as well as our portable generators and blowers.

We want you to get the feel of Homelite Pump and Generator performance. We want you to see a Homelite Pump actually handling 15,000 gallons per hour . . . or lifting water 28 feet . . . or handling seepage or mud and solids without trouble.

Yes, and we want you to see a Homelite Generator operating floodlights, electric tools, radios, communications.

More than that, we want you to see how portable these gasoline-engine-driven units are and how easy they are to operate.

That is why we offer free demonstrations of Homelite Portable Pumps and Generators *on your job,* any time, any place. Write for a demonstration today.

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Portable Pumps Generators and Blowers
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IS THIS YOUR SYSTEM OF TRASH AND RUBBISH COLLECTION?

Every municipal government official interested in the problem of trash and rubbish collection should investigate the simplified Dempster-Dumpster system for lowest possible operating costs. For the complete story with full details and illustrations, write for "The Dempster-Dumpster System" now. Dempster Brothers Inc., Knoxville 17, Tenn.

Contrast the typical city trash collection method, shown at top of this page, with the Dempster-Dumpster Kolector views, above, on opposite page. Other photos on this page illustrate how the Dempster-Dumpster Hoisting Unit picks up, hauls and dumps, automatically, a loaded Dempster-Dumpster Kolector of 10 cu. yds. capacity.

STOP WASTE IN MANPOWER MONEY, ENERGY!

The Dempster-Dumpster system of trash and rubbish collection is first, a clean, sanitary, faster, and simplified method. Second, it is a positive, low operating cost system because a single truck, with Dempster-Dumpster Hoisting Unit, can do the work of 4 to 5 ordinary trucks, and because small pick-up trucks take the place of heavy trucks for residential collection.

The Kolector, is designed for residential service. Other bodies, such as those shown below, are for apartment, hotel and congested business service.

This revolutionary system comprises a single hoisting unit which serves multiple bodies, of various designs, for handling any type or any quantity of trash or rubbish with unprecedented ease. Minimum investment in rolling equipment is a major feature. In this plan, all truck bodies, ranging from 4 to 10 cubic yard capacities, are actually trash and rubbish depositories, picked up at regular intervals, hauled to point of dumping and returned to position, all of which is a one man operation and hydraulically controlled at driver's seat.

DEMPSTER DUMPSTER

TRADE MARK REG.

Flexible Service trucks complete with experienced crews and special Flexible-developed tools are strategically located in all sections of the U.S.A. to give pipe cleaning service quickly.

ONCE UPON A TIME a city thought their underground pipes couldn't be as bad as this until we cut this sample from their lines. Yet many cities are paying the high cost of pumping through lines like this where the C-Value is one-third the original and where friction loss is better than 50%.

New building activity increases the need for water. Will your city be ready? *Clean your old lines first* before you add new and larger water mains. Any degree of tuberculation in a pipe line penalizes your business with higher pumping costs, higher water bills, higher insurance rates, lower pumping capacity and lower customer convenience.

Write or wire today and have Flexible estimate the cost of a thorough pipe cleaning job. Flexible Service trucks with complete crews and tools are strategically located to serve you.

FLEXIBLE WILL CLEAN ANY PIPE FROM 2 TO 72 INCHES

Flexible UNDERGROUND PIPE CLEANING CO.

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When you need special information—consult the classified READER'S SERVICE DEPT., pages 71-73

Busiest Tractor in Town - -

It's an INTERNATIONAL

Digging, bulldozing, grading, shovelling, loading, lifting, carrying and hauling all day long and often into the night! That's the routine of an International Crawler Tractor when equipped with a dozer-shovel. And never time out for changing equipment!

Busiest Tractor in town because it's a time-saver, money-saver and man-saver! For a dependable, sure-footed tractor, you can't beat an International.

18 Reasons Why

1. Full-Diesel engine. **2.** Easiest starting Diesel. **3.** Replaceable cylinder sleeves. **4.** Tocco-hardened crankshaft. **5.** Full-pressure engine lubrication. **6.** Large, accessible over-center type engine clutch. **7.** Fast, easy gear shifting. **8.** Wide speed range. **9.** Big, easy-operating, multiple-disc steering clutches. **10.** Liberal use of ball bearings and bearing cages. **11.** Positive track alignment. **12.** Track shoes keyed to track links. **13.** Outstanding track roller, sprocket and idler dust seals. **14.** Track frames mounted by ball-and-socket joints on pivot shaft. **15.** Every size tractor available in two treads. **16.** Well-located mounting pads for attaching equipment. **17.** Comfortable seat and convenient controls. **18.** Individual unit accessibility—for low maintenance costs.

International Industrial Power Distributors, located in all principal markets, supply not only International TracTracTors, Wheel Tractors and Power Units but also tractor equipment that's matched to them and to the job. In addition, these organizations have unexcelled, factory-level service facilities for keeping International Tractors and Engines—and matched equipment—in prime working order with minimum down time.

Consult the International Industrial Power Distributor near you, now, for aid in selecting the tractors, engines and equipment you need.

Industrial Power Division

INTERNATIONAL HARVESTER COMPANY

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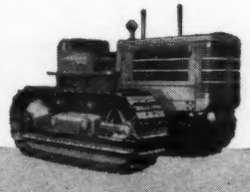
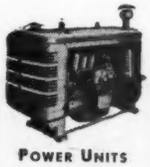
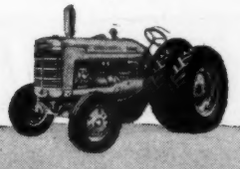


TRACTRACTORS



POWER UNITS



WHEEL TRACTORS

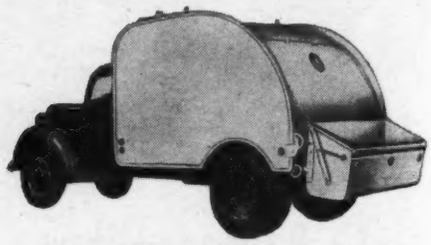
INTERNATIONAL INTERNATIONAL HARVESTER **Industrial Power**

The BEST COSTS LESS

For years Gar Wood has consistently offered truck and trailer equipment of utmost utility and outstanding value. Leadership in this field resulted from this policy. Gar Wood equipment costs less in the long run because it is better built to give peak performance and lasting satisfaction.

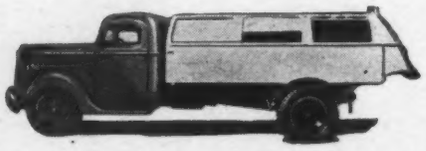
The Load Packer (patented) all enclosed garbage and refuse unit. Compresses loads hydraulically for maximum payloads.

Type C28 scow end Garbage Body. Steel hinged covers extra equipment.



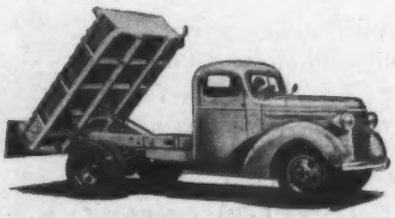
The new Bucket Loader, an all enclosed sanitary refuse disposal unit.

Street Flushers and Sprinklers.



Type C50 Garbage Body with sliding steel covers on each side.

Model "QD" Tree-moving Crane. Easily erected or removed from all purpose stake body.



Type C12 Body and Model D6 or D7 Hoist. Dumping angle 55°.

Telescopic boom Crane. Boom radius 8 to 20 feet.

Special W28 Garbage Body, watertight top box. Capacity 7 cu. yds. Type T333 telescopic Hoist.

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WORLD'S LARGEST MANUFACTURERS OF TRUCK AND TRAILER EQUIPMENT

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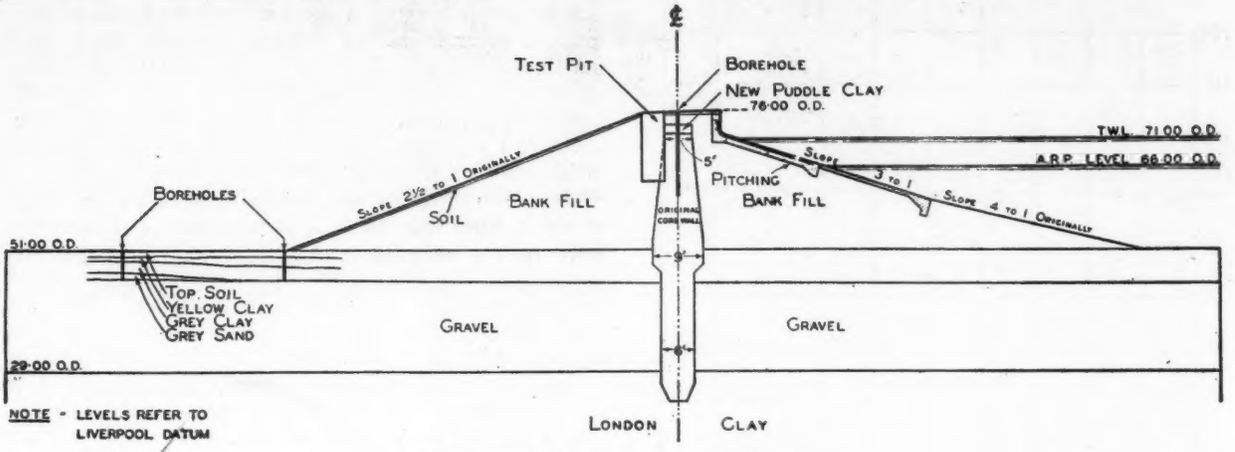
VOL. 77. NO. 7



Typical section of the embankment that failed.

Studying Causes of Failure of a Leaking Clay Core Wall

By ALAN W. BISHOP

Results of investigation into causes of leakage of a large reservoir, the water level of which had been lowered during the war. From a paper before the Institution of Water Engineers of England.

THE water level of an English reservoir was lowered in Sept., 1939, as a precautionary measure in case of enemy damage to the dam. When the water level was raised in Feb., 1945, from 66.0 to 70.5 ft., so much water appeared at the toe of the dam that failure was feared and the water was lowered to 68.0-68.5, at which level slight seepage continued. The profile of the dam, which was built in 1908-1912, is shown herewith. The core wall is of puddled clay obtained from the interior of the reservoir and keyed into the London clay subsoil as shown. Due to gradual settlement of as much as 3 ft. in places, the core wall was topped with puddled yellow London clay, and the embankment raised to original grade in 1939-40.

To determine if the leakage indicated the beginning of a major failure, and to establish the cause of leakage, about two dozen test pits were excavated to expose the outer face of the core wall and seven boreholes were put down. The test pits immediately outside the core wall showed that water was, in fact, passing through the puddle core just below the level at which the water was standing in the reservoir—about 68.5. The upper portion of the core wall, except for the portion placed recently, was in a "cracked and deteriorated state." The evidence of the examination indicated that (1) leakage was taking place through the upper belt of the core wall; (2) was probably confined to this zone; and (3) did not represent the beginning of serious failure.

As it seemed that the seepage was confined to the upper portion of the core-wall, boreholes were put down into the core-wall to investigate the extent and depth of the deterioration, and to try to establish its causes. Various tests of the clay were made, including:

(1) Measurement of the Atterberg liquid and plastic limits, as an indication of the clay type and of its behavior under different moisture contents.

(2) Compression tests, as a measure of its rigidity and loss of plasticity, and as a direct indication of drying out.

(3) Moisture content.

(4) Shrinkage tests, as a direct measurement of the volume at different moisture contents, and of the potential capacity for shrinkage.

(5) Mechanical analysis of the grain size distribution.

Of 19 sections, examined, 12 still showed signs of seepage with the water level at 68.5. All showed the same general clay type and formation but the extent of deterioration varied considerably. Three principal zones could be distinguished, particularly at the sites where the deterioration was more advanced.

(1) A lower zone, from about El. 56.0 to 66.0, the upper level of the water for the duration of restriction, and probably the water table in the core-wall during that period. The clay was a very uniform blue-gray in color and had a "muddy" smell. It was not very plastic or ductile, although slight working with the fingers soon gave it these properties, and it was intersected with a well-developed "slickensides" structure, the polished faces of which sometimes were several feet in depth and notably parallel to the face of the core-wall. The moisture content was between 70 and 80 per cent, and the liquid and plastic

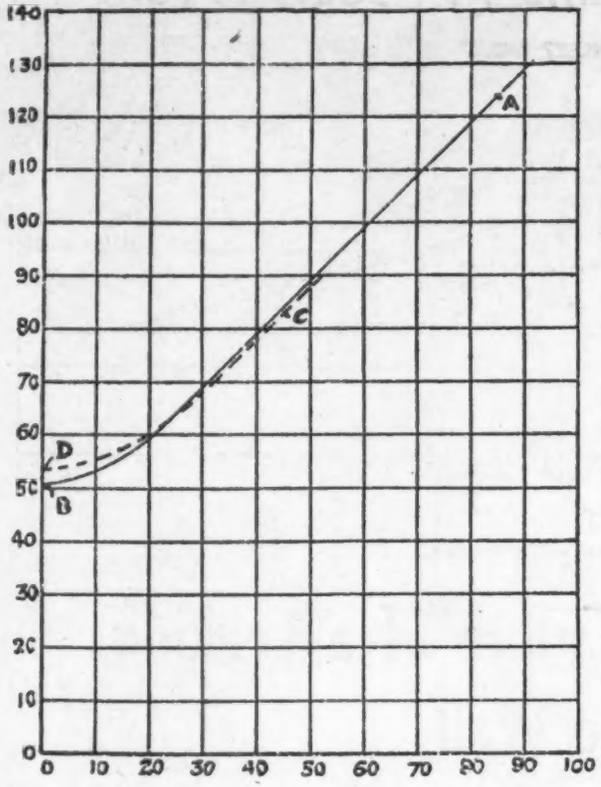


Fig. 2. Expansion of clay. Left scale, % expansion of dry clay; bottom scale, % moisture content.

limits about 130 and 45 respectively. This zone was free from all but the slightest seepage.

(2) An intermediate zone from about 66.0 to an upper boundary which at the outer face of the core-wall probably corresponds to the normal water table in the core-wall when the reservoir was full. The clay was basically blue-gray in color and intersected with slickensides in all directions, many of which were stained with iron oxide on their surfaces, varying to vivid red-brown and ochre; and there were brown lumps with blue cores. The faces of the slickensides were moist or actually had water running over them. The clay was very poor and broken and almost fell away when exposed on a vertical face. In this zone, where seepage was generally found, there was evidence of root penetration. Drying out was more pronounced toward the upper part of this zone, but working with the fingers readily restored plasticity. The clay type was the same as in zone 1, and the liquid and plastic limits were the same, but the moisture content was lower, generally between 65 and 75 per cent.

(3) An upper zone which extended from the upper boundary of zone 2 to the top of the old core. This corresponded roughly to that part of the clay which had been above the normal water table in the core-wall, or had come below water level due to the settlement of the embankment. This clay was very hard and dry, gray-brown in color, very fissured, and with individual cracks up to ¾ in. in width and one or two feet in depth, besides many smaller cracks. Though worse toward the outer face of the puddle, the cracking could be traced throughout the full width of the core-wall. The clay was often columnar in structure and faced with a fine root network. The surface showed traces of iron oxide staining, particularly below the normal top water level. At the junction with the new top layer of puddle, the old core-wall was appreciably softer at some sections.

This zone was of the same clay type as the previous zones, but its moisture content was lower, about 55 to 60 per cent. The new yellow London clay puddle layer is of an entirely different clay type; its liquid and plastic limits are about 80 and 30 respectively, and its moisture content in the core-wall about 40 per cent. Although it was plastic and tenacious and signs of drying out were less, there was some evidence of root penetration, and slight fissures.

In order to appreciate the changes that have taken place in the three zones, it is necessary to have some idea of the original state of the clay used in the core-wall. The clay from which the core was made ranged in color from yellow to black and was of a soft, buttery type. The puddle was placed in the normal way, in 9-inch layers in the trench and in 6-inch layers above ground, after pugging, and it did not possess the structure, planes or root formation that were found after failure. The fact that slight working with the fingers without the addition of moisture gives it plasticity and tenacity is some indication of its original character.

The changes which have to be accounted for are four in number:

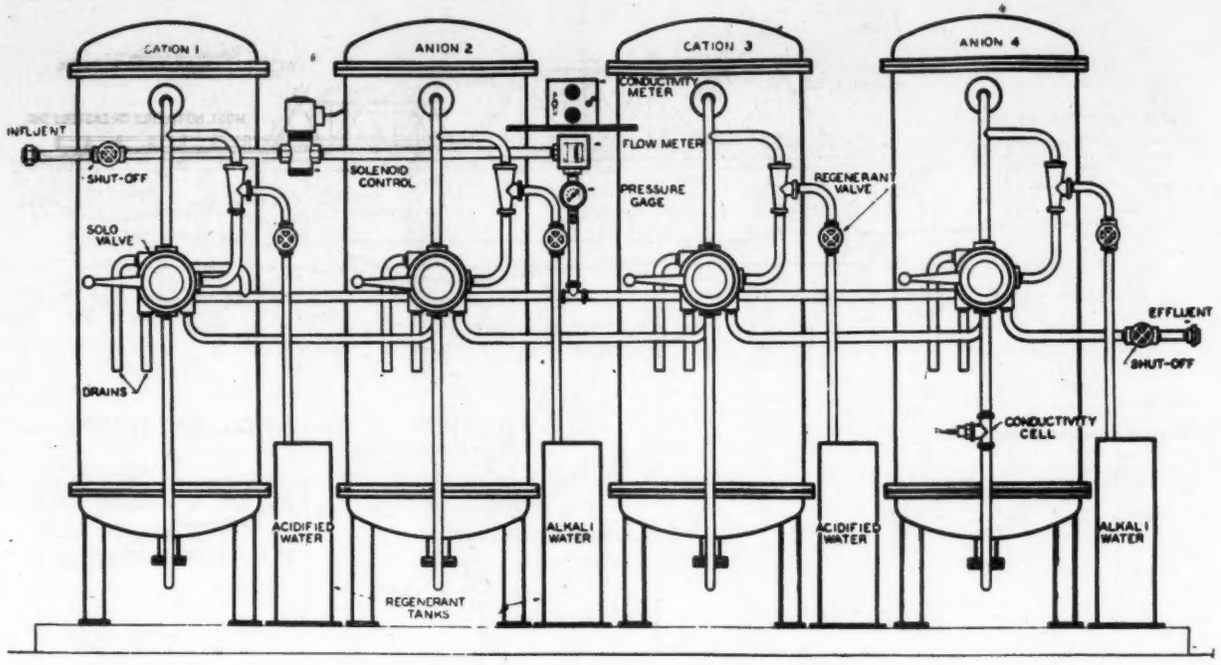
(1) The color change to uniform blue-gray in zones 1 and 2.—This indicates a general chemical change and, as the zones affected lie below the normal water table, can be accounted for by anaerobic decomposition and reduction of iron salts.

(2) The loss of plasticity and formation of slickensides.—Factors affecting these include ageing, chemical action, distortion due to settlement, slight lowering of moisture content and consolidation. Of these, drying is probably a very minor cause, as remolding at the same moisture content restores plasticity. Little has been published about the effects of ageing on puddle clay from the viewpoint of the engineer. Macey[1] notes the temporary nature of the increase in plasticity of potter's clay due to "working" and states that the fatter the clay the more marked is the effect. This behavior of clay pastes is an example of the phenomenon known as thixotropy. The explanation indicated by Russell[2] is that part of the rigidity of the clay is due to linking up water molecules in an orientation to form structural bonds. A mechanical disturbance such as puddling breaks down these bonds and the clay becomes more plastic but on being left undisturbed the bonds reform and increase the rigidity. Hvorslev[3] gives quantitative results for this effect in pastes of two different clays, measuring the increase in shear strength as indicated by a cone penetration strength.

It should be noted that in themselves the slickensides are not a direct source of leakage, but correspond rather to the fissure planes present in stiff clays at great depths.

(3) Additional deterioration leading to seepage in zone 2.—This is almost entirely accounted for by the fact that the zone ceased to be below the normal water table during the years 1939-45. This subjected it to drying out, both through the bank fill and through the medium of roots. The fact that clay in this zone is basically blue-gray, and that brown lumps in it have blue cores, indicates that it is a transition zone formed from the blue-gray puddle under oxidizing conditions. The columnar structure and surface staining of clay is associated in agricultural science with alternate wetting and drying. The erratic mois-

(Continued on page 34)

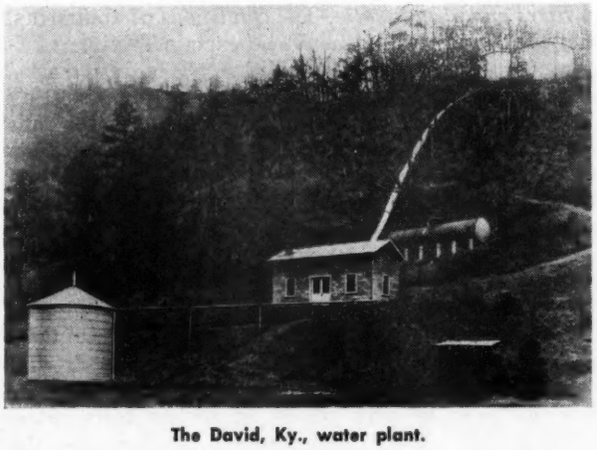


Set-up of ion-exchange plant for David, Ky.

Ion-Exchange Process Permits Use of Water With 2500 PPM Total Solids

The successful use of a new ion-exchange system of water purification for supplying, from local sources, the entire domestic water needs of a typical mining village has been reported by American Cyanamid & Chemical Corporation. This is believed to be the pioneer application of such a method to a municipal water supply. The new process involves the use of resins and is stated to be comparable to simple cold filtration. Its use makes possible the economical removal of dissolved minerals from extremely brackish water.

For years, David, Kentucky, a small mining town, had been bringing in the daily domestic water requirements of its 100 families by tank truck, over nearly ten miles of mountain roads. The water was stored in a 60,000-gallon reservoir tank in the village, and fed by gravity through black iron pipes to the taps in town. Since this system brought water costs to about $1,600 a month, other methods of obtaining potable water were investigated.



The David, Ky., water plant.

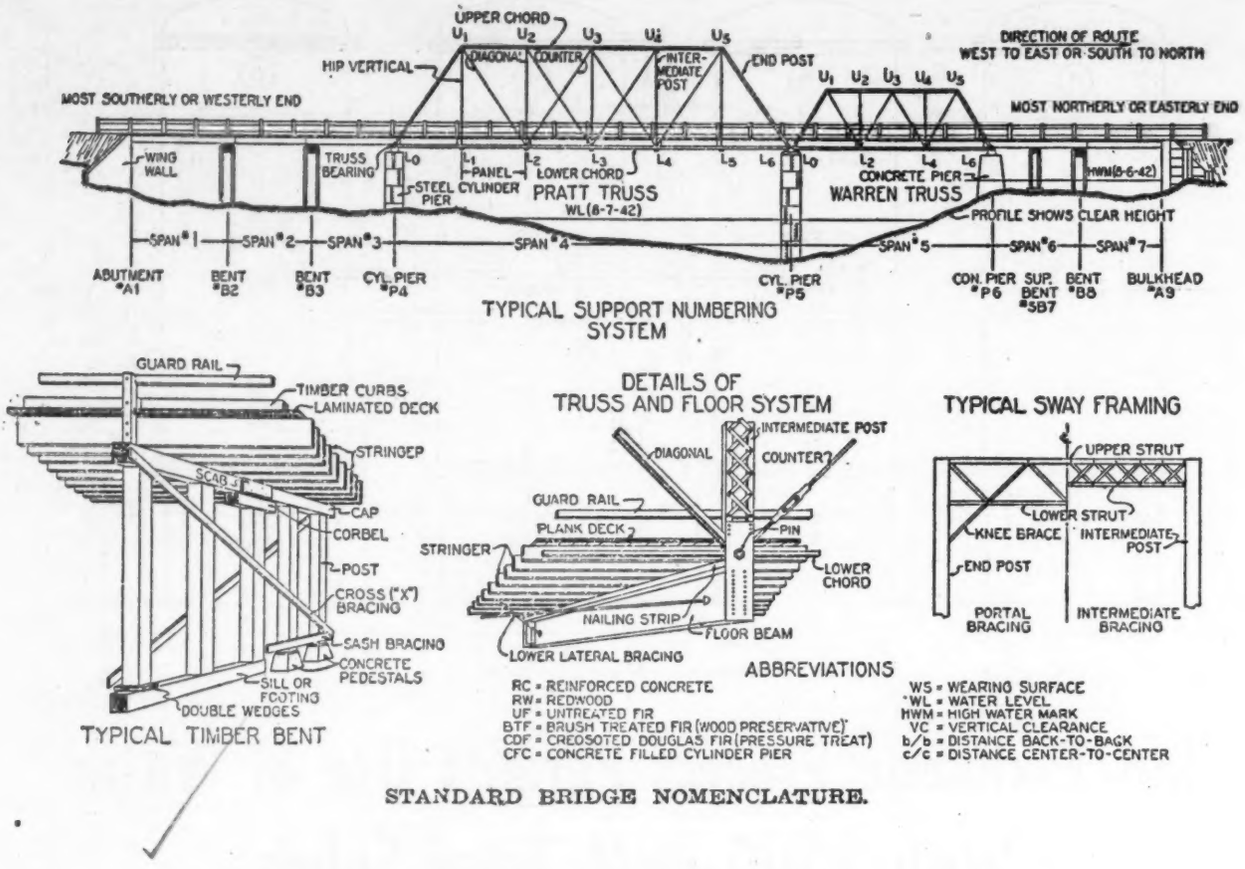
All surface water in the region is hard and salty. Wells drilled in the area yielded undrinkable, brackish water containing 2,500 to 3,000 parts per million of total solids. After investigation of several methods of reducing this solids content enough to make the water palatable, an ion-exchange unit, called the Filt-R-Stil, illustrated herewith, was installed.

This unit, in operation since the first of this year, has been producing approximately 9,000 gallons of potable water in a 9-hour operating day, and effects about an 85% reduction in the solids content of the water; the final water averages about 400 ppm of total solids, none of which is hardness. The dissolved solids remaining in the water give it a pleasant taste yet leave it soft and satisfactory for all domestic uses. The latest reports indicate that the chemical cost of operating the unit is about $400 a month—about one-fourth of previous water costs. The operation and maintenance of the unit is reported to be simple and to require only a part of one man's time.

The theory behind the process used embodies one of the new concepts in physical chemistry—ion-exchange. New synthetic resins have been developed which have the ability to remove or exchange ions from solution. Since the hardness and saltiness of water is caused by mineral salts and acids which, in water solution, dissociate into ions, water passed through beds of these resins can be practically completely demineralized.

Filt-R-Stil equipment consists essentially of four columns arranged in series and containing alternate beds of cationic and anionic exchange resins. The cationic exchangers act to change salts into correspond-

(Continued on page 39)



STANDARD BRIDGE NOMENCLATURE.

Bridge Inspection Procedures and Bridge Maintenance

PERIODIC inspection of all bridges is necessary (1) to insure the discovery of weaknesses or structural defects in time to permit necessary repairs; (2) to provide a basis for service records from which to determine the relative values of the different types of construction; and (3) to furnish a basis for the preparation of an annual maintenance and betterment budget for the ensuing year.

A bridge is usually defined as a structure having a minimum clear span of a specified length. This length differs in the various states; for instance, in Pennsylvania, it is 4 ft., but in Texas it is 20 ft. The illustration above, from the Instruction Manual of the California Division of Highways, shows standard bridge nomenclature.

Bridges should be inspected once or twice a year by a qualified bridge engineer, and also following unusual conditions, as floods or fires; foremen or patrolmen should inspect bridges routinely every three months. When the engineer makes more than one inspection, one of these should usually be made as soon as the spring floods have subsided and another just before the winter season. Inspections of bridges over streams subject to heavy scour should be made after every period of high water. A formal record of the conditions found on each inspection should be made on a standard form. In general, the following points should be covered in making bridge inspections:

Waterways—Indications of scouring of a type that might endanger the footings should be noted; also, the presence of obstructions, as drift, logs, vegetation or gravel deposits that might divert the current so as to cause undermining of the piers, or may constrict the waterway or create a fire hazard. Such materials should be removed and the channel cleared within the right-of-way to a normal section. Earth or drift should be removed from contact with wood or steel wherever possible. The condition of existing riprap or channel protection works should be examined and indications of need for additional work of this type should be noted.

Piers and Abutments—The conditions of abutments, piers and wing walls should be examined with reference to their structural condition, including cracks, deterioration, movements, bulging, tipping, settling or slipping. Where the depth of water necessitates, rods should be used to probe around the footing. Erosion should be checked, especially around wing walls, on approach fills and similar places. This may be corrected by backfill with selected materials, paving ditches or slopes with asphaltic mixtures, or installing corrugated metal bank protectors and down drains.

Attention must be given to the conditions and adequacy of concrete bents or piers with reference to their footings, or to cracks that may have developed, with particular attention to damage to or defects in the concrete near bearing plates or anchor bolts. Steel tubular piers should be examined carefully for the

condition of the rivets or bolts holding together the cylindrical sections. The filling in the tubes usually has little strength and if the rivets or bolts are broken, the bearing ability of the pier is greatly reduced. The bases of the tubes should be examined if possible to determine the foundation conditions. If the tubes have tipped, the reasons should be determined.

The condition of timber piling and frame trestle bents should be examined, especial attention being given to decay. This usually starts at the ground line. Decay in timber can be located by tapping with a light hammer; or by probing with a ¾-inch bar, pointed at one end and with a chisel edge on the other (Maryland); Texas recommends the use of a special auger which cuts a core from the timber. In a framed structure, any timber showing material decay should be replaced. Missouri replaces timber piles in which 50% of the cross-section has decayed in the following manner: The pile is cut off 2 ft. below ground surface, or as much deeper as may be necessary to reach sound timber. A concrete footing, about 3 ft. square and 2 ft. deep, is poured around and on top of the cutoff pile with the end of the pile extending at least 1 ft. into the concrete. After the concrete has cured, a sound section of piling is fitted in between the top of the concrete footing and the timber cap. The top of the new pile section is held in place with a drift pin and the bottom by two strap bars embedded in the concrete for half their length. Timber bents should be examined at all contact and bearing points, and attention given to the need for wedging, tightness of bolts and spikes, and effectiveness of bracing.

Concrete Structures—An examination of all girder and slab superstructures should be made to determine the presence of cracks and of clogged or jammed expansion joints. Concrete handrails should be checked for damage caused by collisions. The handrail alignment should also be checked to indicate settlement or movement in the structure. On some skewed bridges there is a tendency for the superstructure to move sideways. The riding surface should also be checked and if exceptionally rough should be leveled. Floors should be examined for their ability to shed water and floor drains for proper functioning.

Steel Truss Spans—An examination of the general alignment will determine if the end posts or top chord sections are buckled or out of line. This is especially important in old or lightly designed bridges. Intermediate members and channel or pipe rails should be examined for damage due to collisions. The condition of the expansion plates, rockers and rollers should be inspected to determine that they are free to move and to provide for expansion. The condition of the paint and the presence of corrosion around rivets and bolts should be checked, and also corrosion of the top chord; debris should be removed from channels and other members forming a trough. All steel below the level of the bridge floor should be inspected for loss of section by corrosion, and timber floors for the condition of the timber, extent of decay, condition of timber curb and the wearing surface. Unusual vibration from passage of vehicles should be noted.

A method of replacing timber stringers in a panel without the necessity of removing the bridge floor is shown herewith. This illustration is from the California maintenance Manual previously mentioned.

Special Features—In order to increase the visibility of bridge ends, California paints with white lead and oil or traffic lacquer the cover plates

DETAIL BRIDGE INSPECTION REPORT

County_____ Route_____ Station_____ Twp._____ Stream or RR____

Span_____ Clear_____ Type_____
Material_____ Skew____ Rt.-Lt.-Ahead____

	Condition	Remarks
SUBSTRUCTURE		
Bearing Foundations		
Stream Bed Paving		
Abutments or Columns		
Bridge Seats		
Back Wall		
Wing Walls		
Piers		
General Condition of Substr.		
SUPERSTRUCTURE		
Bed Plates and Rollers		
Flanges or Chords		
Web or Diagonals		
Counters		
Pins or Rivets		
End Post		
Parapets or Handrails		
Floor Beams		
" " Connections		
Stringers		
" Connections		
Hangers		
Reinforced Concrete Slab		
Expansion on Bearings		
Wheel Guard or Curb		
Sidewalk Brackets		
" Stringers		
" Flooring or Slab		
Roadway " " "		
Wearing Surface		
Laterals		
Sway Bracing		
Portals		
Arch Ring		
General Condition of Superstr.		

GENERAL

Action under Traffic_____
Approaches: Alignment_____ Grade_____
Paint_____ Approx. year for Repainting_____
Cleanliness_____

STREAM CONDITION

Character of Watershed_____
Does All Water Pass Under Bridge - Or Partly Over Approaches_____
General Character of Stream Bed and Banks_____
Do Ice or Drift Jams Occur_____
Where and to What Extent Has Scour Occurred_____
Is Waterway Opening Sufficient_____
High Water Elevation_____

RECOMMENDATIONS: NEW CONSTRUCTION____ RECONSTR.____ REPAIRS____
Estimated Cost of Replacement or Repairs_____
Safe Load Posting____ Tons____ By Whom____ Overhead Clearance____

Use for description of conditions, "Good-Fair-Poor-Dangerous"

Inspected by_____
Date_____

Owner_____ Maintained by_____ Type_____
Leg. Act. No._____ Extent_____ No. of Spans & Length_____
Erected_____ PSC-PUC Order No._____ Underclearance_____
By_____ Dated_____ Clear Rdwy. Width_____
Cost_____ Plan No._____ Skew____ Rt.-Lt.-Ahead____

Steel, Iron or Timber Bridges

Members Vert. Clear	Type	Safe Load	Mat'ls And Size	Span C-C Bear. or Length	Panels or Spacing	C-C Trusses C-C Girders *	C-C Chords B-B Flgs.	Connected With
TRUSSES								
GIRDERS			*					
FLOOR BEAMS								
STRINGERS								
RDY.FLOOR			O-O Width____ Thickness____					
SIDEWALKS			Number____ Side____ Width____ Thickness____					
WEAR.SURF.			Width____ Thickness____					

Concrete or Masonry Bridges

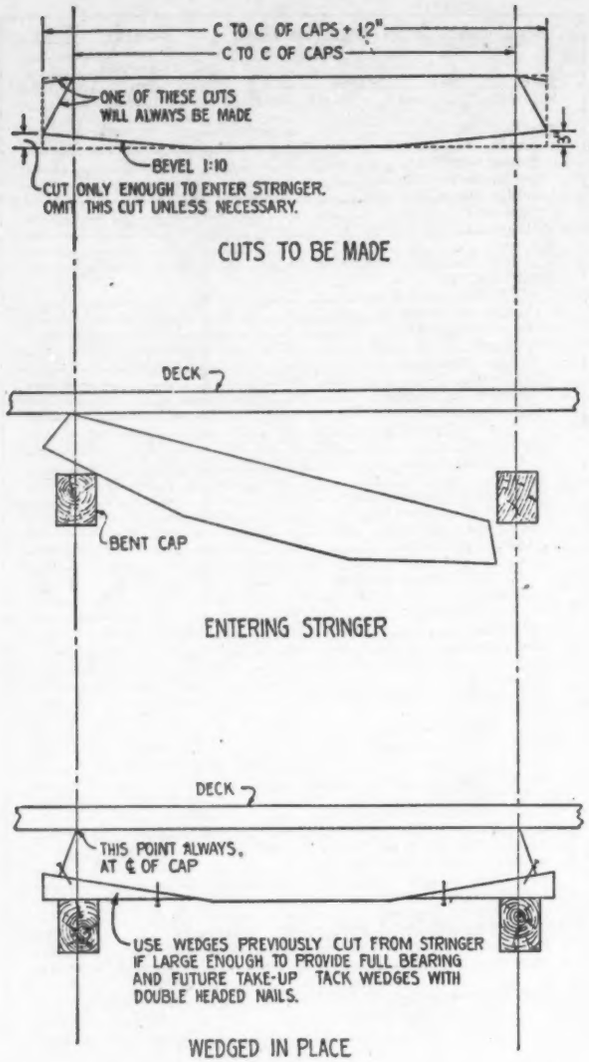
Type	Fill Ht.	Span	Effective Span	Under Clear	Plan No.	Material	Condition	Safe Load	Sidewalks No.	Sidewalks Width	Sidewalks Side

Substructure

	Height	Material	Condition	Plan No.	Founded On	Acid Protection
ABUTMENTS						
PIER						
TEMP. BENT						

ATTACH SKETCH: (A) Plan including approaches, length of wings, abutments and piers (B) Side Elevation of Bridge showing outline of structure, clear spans, width of abutment and pier tops, underclearances, grades and profile on centerline of roadway including approaches (C) Cross Section of bridge showing roadway and sidewalk widths, overhead clearance, superelevation, etc. Show location of occupancies on plan, elevation and cross section by dashed lines and solid circles.

Bridge inspection form above. Below, bridge record sheet—front (reverse on next page). These forms adapted from Pennsylvania Highway Dept. standards.


C TO C OF CAPS + 12"
C TO C OF CAPS
ONE OF THESE CUTS WILL ALWAYS BE MADE
BEVEL 1:10
CUT ONLY ENOUGH TO ENTER STRINGER. OMIT THIS CUT UNLESS NECESSARY.
CUTS TO BE MADE
DECK
BENT CAP
ENTERING STRINGER
DECK
THIS POINT ALWAYS AT ℄ OF CAP
USE WEDGES PREVIOUSLY CUT FROM STRINGER IF LARGE ENOUGH TO PROVIDE FULL BEARING AND FUTURE TAKE-UP TACK WEDGES WITH DOUBLE HEADED NAILS.
WEDGED IN PLACE

Method of cutting and placing stringer.

of end or batter posts, hand railings on bridges and the end posts of guard rails. California also paints a high water mark, with the date, on any convenient abutment or pier. This is a white line 1 inch wide and 18 inches long, and shows the highest mark of record on all major streams (see extreme upper right corner of page 22). Wooden bridges are provided with water barrels and 10-qt. round-bottom buckets.

California also fills large cracks or checks in timber with a putty-like mixture of wood preservative and ground asbestos; enough of the latter is added to 3 gallons of the former to make up to 5 gals. The timber is first painted with preservative and the cracks then filled. Missouri recommends that all bridges on gravel roads have 100 to 150 ft. of the approach paved with bituminous surfacing to eliminate the hazard from dust, the distance depending on local conditions.

Texas grants permits for pipe lines on highway bridges only under the following conditions: (1) The pipe line shall be so attached as not to interfere with the flow of water under the bridge, or with pedestrian or vehicular traffic on the bridge; (2) The pipe line owner shall be liable for all damages either to the bridge or to the public; and (3) An annual rental is charged commensurate with the cost of a bridge necessary to carry the line.

Other Conditions—All surfacing, flooring and decking should be inspected to insure that it is correctly in place, solid and in good condition. Special hazards on bridge approaches, such as narrow roadways, lack of rails, low capacity, sight obstructions of sharp curves should be noted and reported. Trees growing near a bridge, which may be undermined by high water and which, in falling, may injure the bridge or block the waterway should be removed.

Culverts and Underdrains — Particular attention should be given to the inspection of culverts, underdrains and bleeder and shoulder drains. Underground drainage structures should be located from construction drawings and marked with red or other easily identified stakes so that they can be examined frequently and maintained in good condition.

Acknowledgments—These data were taken from the several manuals and publications of the Missouri State Highway Department, the Pennsylvania Highway Department, the California Division of Highways, the Connecticut State Highway Department, the Maryland State Roads Commission, and the Texas Highway Department.

Inadequate Road Barrier at Downgrade Curve

The State is required to erect proper and sufficient railings or barriers along the highway at places where they are necessary to make the highway safe and convenient for travelers using ordinary care; and the State is liable for injuries to travelers resulting from a breach of this duty. The defense that the accident occurred outside the patrol period provided for in the New York Highway Law (May 1st—November 15th), and for that reason the State could not be held to respond in damages for any defect in the highway, was held not available where the condition complained of had existed and the State had knowledge of it for years. (Ferm v. State of New York, Court of Claims, 60 N. Y. S. 2d 124.) In this case damages were recovered for the death of a motorcyclist, whose motorcycle struck an embankment after leaving the highway at a curve on a downgrade and precipitated the cyclist into a creek about 32 feet below. The court held that three triangular concrete posts, spaced at 8-foot intervals, with only a log placed on the ground against them, was inadequate to constitute a proper barrier or guard "at this perilous spot."

Sheet____ Of ____
County____ Leg.Rt.____
Twp.____ Appl.____
Boro.____ Tr.Rt.____
City____ Sta.____
Str. or Railroad____
Field Book No.____ Page____
Quad.____ N____ E____
Drain.Area____ Mi. Runoff____
Str.Slope____ % Scaled-Surveyed
Opening____ Ft.____ Effic.____
Appr.By____ Date____
H.W.____ Above-Below Br.Fl.Sf.
H.W.Elev.____ Date____
Leg. R/W Width____ Ft. Estab.____
Leg. Slope Limit Ft. Lt.____ Rt.____
Is Bridge Lighted____ By____

OCCUPANCIES

Owner	License	Appr.	Fee
	No.		
	No.		

Inspected By____ Date____
Revisions:

REPAIRS

Date	Character	Cost

PAINTING RECORD

Date	Tons	Area	No. Coats	Cost

Amt. required for last

No.1 R.L.	No.8 S.S.	No.9 Drab	No.12 White	Spar Varn.	Other

PROTECTIVE TREATMENT

Date	Area	Character	Cost

REMARKS

Bridge record sheet—reverse side.

INFILTRATION INTO SEWERS

City engineers' reports, largely in their own words, on amount of infiltration into sewers, with some comments on methods of minimizing it.

STUDY of about 500 questionnaires recently returned to the Editors of PUBLIC WORKS by city engineers indicated that infiltration of ground water or the entrance of storm water offered a serious problem in more than one-third of the total—and not all of these 500 cities had sewer systems.

Of the cities replying, 36 reported "quite a little" infiltration; 49 said they had "considerable" or a "large amount"; 32 stated infiltration was "excessive" or "very heavy"; in 14 it was "high during storms"; 28 others estimated infiltration quite regularly amounted to nearly 25% of the flow; and 11 said it was normally up to 50% or even higher.

More than 200 cities reported on the types of sewer joints they preferred or had found especially effective in preventing infiltration. Of these 76 merely said "bituminous", "mastic" or "poured" joints; 46 relied on concrete, with a number mentioning the Weston gasket specifically. About 75 gave specific names of the joints or joint materials they preferred, at least 13 of these being mentioned, including Tegul, GK, Leadite, Jointite, Bitumastic, Kalktite, Slip-seal, Presstite, Puro Seal, Tufflex, Sanitite, Korite and Stonetite.

Comments in regard to this problem by city engineers follow: In Colorado, Boulder has not determined the exact amount of infiltration, but believe it to be considerable. So far, only cement mortar has been used for joints. Lamar is now making a study of the situation.

High Tides Complicate the Problem

The situation in St. Augustine, Fla., is complicated by the backing up of tide water in the sewers. Columbus, Ga., estimates infiltration at "about 1900 gallons" (presumably per mile per day). In Thomasville, Ga., infiltration amounts to 800,000 gpd. in wet weather. In Lewiston, Idaho, it amounts to as high as 50% of the sewage flow, depending on the height of water in the river.

Streator, Ill., estimates infiltration at 5,000 to 10,000 gallons per mile; Urbana, Ill., "would like to know of a sewer joint material that is effective in preventing infiltration" of which they have "considerable." Des Moines, Ia., estimates infiltration in the wet season at 20% of the sewage flow and "finds asphaltic type joints very satisfactory for preventing it." In Waterloo, Ia., infiltration is "approximately 1,000,000 gpd."

In Kansas, El Dorado estimates leakage into the sewers at "30 gals. per person per day"; Emporia has trouble "during wet weather only"; and Liberal has very little infiltration and that results mainly from tree roots entering the sewers.

Danville, Ky., reports infiltration as "heavy during storms"; Brunswick, Md., estimates it at 50,000 gpd.; in Brockton, Mass., it is nearly 1 mgd. But Peabody, Mass., finding an asset in what for most cities is not merely a liability, but a headache, says "due to the quantities of lime used in various manners in the leather industry, infiltration is small." Both Reading, Mass., and Boyne City, Mich., estimate the infiltration "as a guess", at 100% of the normal flow. It is "too much—approximately 2 mgd." in Marshall, Mich., but in Mason, Mich., it is "very little as all joints are asphaltic." Port Huron, Mich., estimates infiltration at 1 mgd to 1.25 mgd.

About one-fourth of the sewage in both Albert Lea and Fairmont, Minn., is due to infiltration; in Chisholm it is "about 28,000 gallons per mile of sanitary sewer." Faribault is about to survey the amount of infiltration, which is "too much." Other Minnesota cities have less trouble—Hibbing "considerable in those lines in wet ground"; Montevideo "very little except in one line"; and Springfield "about 25% in the wet season in the NE part."

Infiltration 200% of Normal Flow

Greenville, Miss., reports "200% of normal flow" and Oxford about "100%", but in Pascagoula it is "100% in rainy seasons." Carrollton, Mo., has "excessive" infiltration, which is now being studied. In Columbia, it amounts to double the normal flow, though lead is used for joints. Monroe City reports a heavy flow from basements. St. Charles, Mo., has infiltration that, at times, amounts to 40% of normal flow. Cement joints have been used with fair results. In Springfield, the amount of infiltration is variable but approximates 1500 gallons per mile. "Clapipe compound" has been used for joints.

New Jersey cities report varying problems with infiltration, as follows: Belleville, 5% by volume; Gloucester City, estimated 15%; Kearny, "considerable in meadow section"; Metuchen, "average about 0.4 mgd"; Orange, "30 gals. per capita"; Passaic "uses Transite pipe and joints"; Phillipsburg, about 10%; Princeton, "new sewers less than 5,000 gals. per mile; old sewers 2 to 300% increase in wet weather; uses dry oakum with bituminous joint; new sewers tested hydrostatically under 0.1 pounds pressure; Somerville, infiltration excessive, but unusually effective joint is obtained by using jute soaked in cement mortar with cement; Verona, 300% over dry weather flow; Tenafly, "infiltration up to 75% in wet weather; an effective joint depends more on workmanship than on material." This same statement was made by several others and is, of course, correct.

New York: East Aurora, infiltration is 35% to 75% of the dry weather flow in the spring. Ithaca, up to 4 times dry weather flow. Lackawanna, wet weather flow is double dry weather flow, due mainly to faulty house connections. Olean uses asphaltic joints or Universal cast iron pipe or Orangeburg fiber pipe. Oneida has "a great deal of infiltration as our sewers are laid in quicksand; poured compound joint is most satisfactory." Port Chester, flows increase about 20% during

(Continued on page 36)

Schistosomiasis—

This is one of a series of articles, which will appear in PUBLIC WORKS from time to time, describing various water-borne diseases not generally a problem in the United States. The data herein are largely based on War Department Technical Bulletin Med-167.

SCHISTOSOMIASIS is a disease caused by parasites belonging to the class of trematodes in the Phylum Platyhelminthes or flatworms. It is allied in nature to the swimmer's itch known in our great lakes region, but true schistosomiasis appears to be restricted. according to established occurrence of the disease, to Japan, Formosa, Okinawa, China, the Philippines and Celebes, perhaps upper Burma, along the Chinese border, portions of South America, north and west Africa and the West Indies.

Three species of blood flukes—*Schistosoma haematobium, S. mansoni,* and *S. japonicum*—are agents in the production of the human disease. These flukes have similar life cycles but their respective snail hosts are different and the diseases produced in man vary in effect because of the variations in the anatomical regions involved. The disturbances produced by *S. haematobium* are mainly in the genito-urinary system but the lower colon and rectum may be involved. *S. mansoni* and *S. japonicum* cause disturbances in the small intestines, colon and rectum. In general, infection with *S. japonicum* appears more severe and more resistant to treatment. Infections with *S. japonicum* are sometimes referred to as oriental schistosomiasis or Katayama disease.

The worms live in the intestinal walls of infected persons. The female worms, which are about 2.5 cm. long, deposit eggs which are discharged in the feces. These eggs hatch within a few hours if the feces are

An Overseas Water-Borne Disease

Illustrations adapted from "Snail Fever," by the Bureau of Medicine and Surgery, U. S. Navy.

diluted with fresh water, but do not develop in salt water. When the eggs hatch, ciliated free-swimming larvae, miracidia, are liberated. These seek out suitable snails and invade the soft tissues. After several weeks of development in the snails, free-swimming fork-tailed larvae, called cercariae, are liberated. These are the infective agents so far as man is concerned.

Only certain species of snails are suitable for the development of the cercariae. So far as is known there are no snails in the United States which can act as intermediate hosts, though there are related species in the lower Mississippi valley. Because there are no suitable snails in this country, importation of the disease by returning infected army or navy personnel is deemed impossible. Even though eggs may be discharged, and miracidia develop, the next stage cannot occur.

Only certain species of snails belonging to the species *Katayama, Oncomelania* and *Schistosomophora* are suitable for the development of the cercariae. These snails are amphibious, and are very small in size—3 to 10 mm long or as large as the letter "i" in the heading of this article. They are particularly prevalent in irrigation canals, ditches, rice fields, ponds and sluggish or stagnant water; but they may be found in rapidly flowing water also. Infested water may show no evidence of contamination.

Cercariae emerge from infected snails over a period of several months. These cercariae are very small, measuring only about 0.15 mm in length, and will die within about 2 days unless they can reach a suitable host—men, dogs, cats, horses, cattle, etc. When a host is contacted, the cercariae penetrate the skin or tissue, enter the blood stream and complete their development. Eggs appear in the feces in 4 to 6 weeks. Early symptoms of the disease appear in 3 to 10 weeks, usually 5 or 6 weeks.

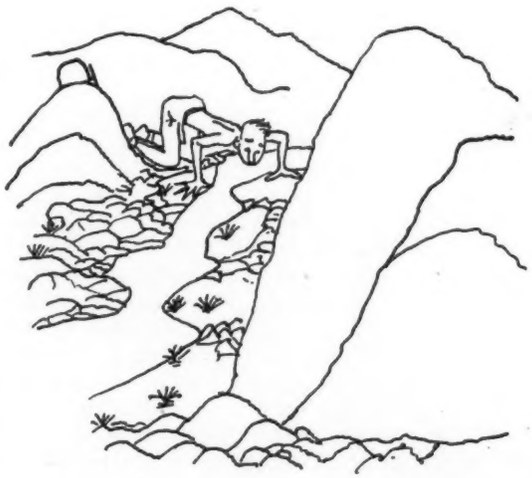
Infection is acquired by wading, swimming, bathing, being splashed by, or drinking infested water. A few minutes contact is sufficient to produce infection. Ordinary clothing does not offer protection against the cercariae. While proper disposal of human waste may reduce the intensity of infestation, positive treatment of water is necessary for prevention of the disease due to the fact that many common animals may harbor *S. japonicum* and spread the infection; swimming, wading, washing clothes or vehicles, or washing in untreated water must be avoided. It is possible to treat small pools to kill the cercariae, but they cannot be controlled in streams.

Cercariae may penetrate sand filters of any type, so far as is known, no matter what method of operation is followed. This applies to rapid sand filters, preceded by coagulation and settling, even when operated at rates as low as 2 gals. per min. per sq. ft.; to slow sand filters; and to the army portable and mobile sand filters. The diatomite filter, if the septa are coated with diatomacious earth, will remove the cercariae, as will the pad-type filters, using a paper pad as the filter agent.

Heating of water to 125° F will kill the cercariae. Storage for 48 to 72 hours is also effective if the snails are excluded from the stored water. The cercariae will die during this period, but if infected snails are present, more cercariae will be released. Therefore careful straining, using a fine screen, preferably 60 to 100 mesh, is necessary. Subsurface water should be used so far as possible.

Fortunately, chlorination is effective in destroying the cercariae. A chlorine residual of 1 part per million after 30 minutes is ample, and chloramines appear to be as efficient as free chlorine. It is believed that iodine in the same concentration is equally effective; and halazone in concentrations usually employed in canteen sterilization (about 4½ p.p.m. in clear

(Continued on page 38)



THESE GUYS ARE REALLY ASKIN' FOR IT!

Placing preleveling course to correct crown.

General construction view of a job.

Ohio Uses Hot Mixed Asphalt for Surfacing, Salvage and New Construction

Condition of the old base or pavement determines construction practice on the job. All plans provide material for leveling and surface courses and in addition extra leveling material for crown and profile correction. If the old base or pavement is quite rough or has weakened sections, a preliminary leveling course is laid with the extra leveling material for either the entire length or over the sections that are very rough. In addition wedge courses are used properly to superelevate curves and reduce excessive crown. This procedure is generally followed whether a pavement is just to be resurfaced or widened and resurfaced. This has been found to give better results than where grades are established and followed, and affords better control of material. Quite an item of engineering cost is also saved. Before any hot mix is placed, the old base or pavement is thoroughly cleaned and a tack coat or prime is applied, as the need may be. Tack coats are used on Portland cement concrete, brick, and macadam bituminous surface treated pavements. Prime coats are used on traffic bound, new macadam, stabilized, and old dry bituminous surfaces.

Widening Procedures

If a pavement is to be widened, excavation is done after the old base or pavement has been corrected with the preliminary leveling course. Trenches for widening are excavated either with a motor grader or a specially designed excavator mounted on a truck chassis. If a motor grader is used, most contractors attach a short section of mouldboard to the end of the mouldboard of the motor grader. This short section is of such length that it fits the width of the trench being excavated. The opposite end of the mouldboard of the grader extends over the pavement and is equipped with a shoe to control the depth of cut. If the excavating or trenching machine is used it is operated from the corrected pavement surface. The trencher does the best job as it excavates to grade and cuts to neat lines, thereby eliminating subgrade adjustment by hand and affords a vertical shoulder at the outer edge of the trench to confine base courses if forms are not used.

Immediately on the compacted subgrade is placed an insulation course either of limestone or slag screenings. This course is 1¼ inches in depth compacted. Placing is usually accomplished with specially designed widening boxes. These boxes are mounted on wheels and run on the pavement. Widening boxes are equipped with a hopper, a transverse conveyor, and an adjustable strikeoff extending over the trench. Some boxes are self-propelled and some are equipped with power for the conveyor and pulled by a truck as it dumps material into the hopper. It is usually necessary to water the insulation material, either in trucks as it is loaded or after it has been placed in the trench, in order to facilitate its consolidation. After the insulation material is placed and compacted, the edge of the existing pavement that has been previously cleaned, is further cleaned of any screenings and thoroughly sealed with bituminous material. Sealing is performed with either brush or spray on rigid pavements and with spray on other types. Power sprays are generally used on all work as they are great time savers and do a more thorough job. Procedure usually requires the use of the same bituminous material that is in the mix for edge sealing and for all surfaces against which bituminous concrete mixes are abutted.

Hot bituminous mixes are placed in the widening trenches with the same widening boxes that are used to place the insulation course. Base courses in widening trenches or in full width construction never exceed 3 inches in depth compacted. Compaction in widening trenches under 4 feet in width is secured with trench rollers. The trench rollers are so constructed that an outboard wheel operates on the existing pavement and the compression and steering roll on the material in the widening trench. A vertical adjustment of sufficient latitude is provided on the outboard wheel of the trench roller that it may be adjusted to the correct height for the course being compacted. Specifications require that the compression rolls, of the trench roller, have 300 pounds weight per inch width of the roll. Maximum capacity of trench rollers is set at 0.8 tons per hour per inch width of compression rolls. On full width construction, and in widenings of sufficient width, compaction of base courses is accomplished with standard tandem or three-wheel finishing rollers

Joint blending device on Barber-Greene paver.

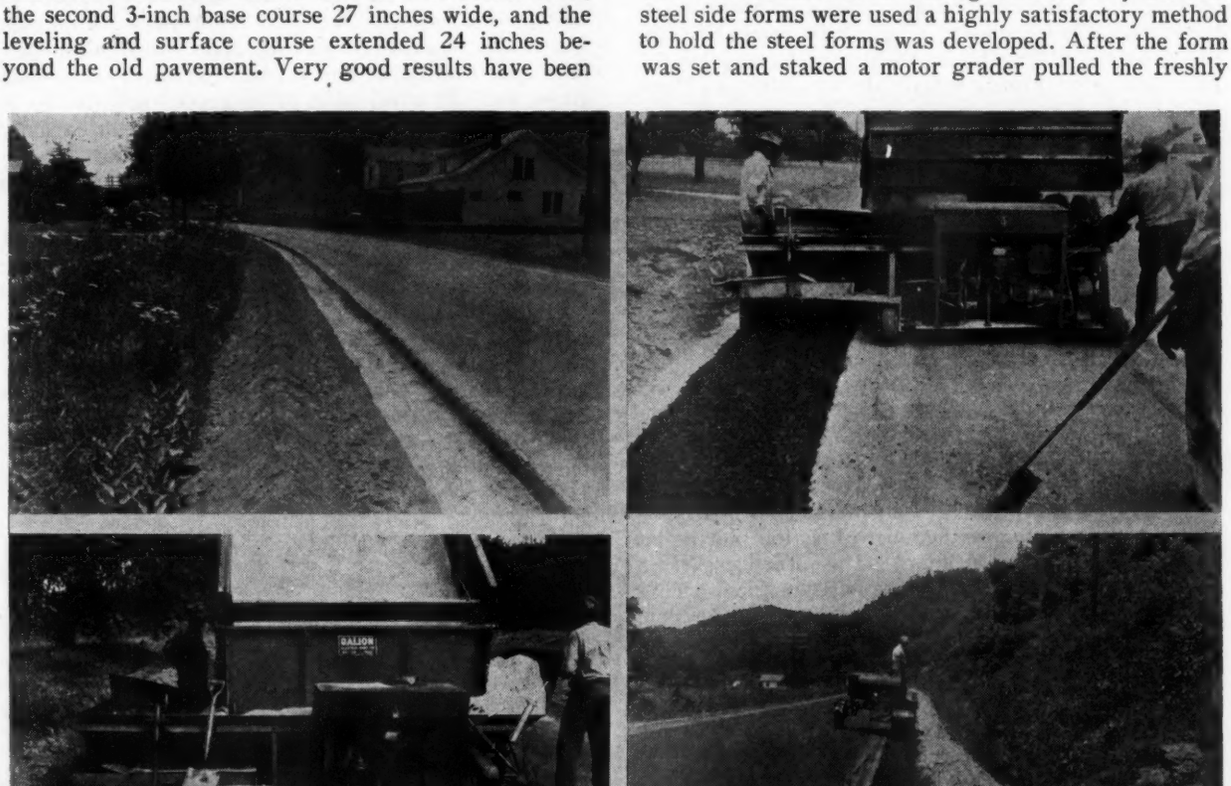
Welding a new seat on a catch-basin to raise it.

Outline of program under way in Ohio; bases of design; testing and laboratory control of paving mixes; bituminous plant requirements; details of construction practices. Continued from the June issue.

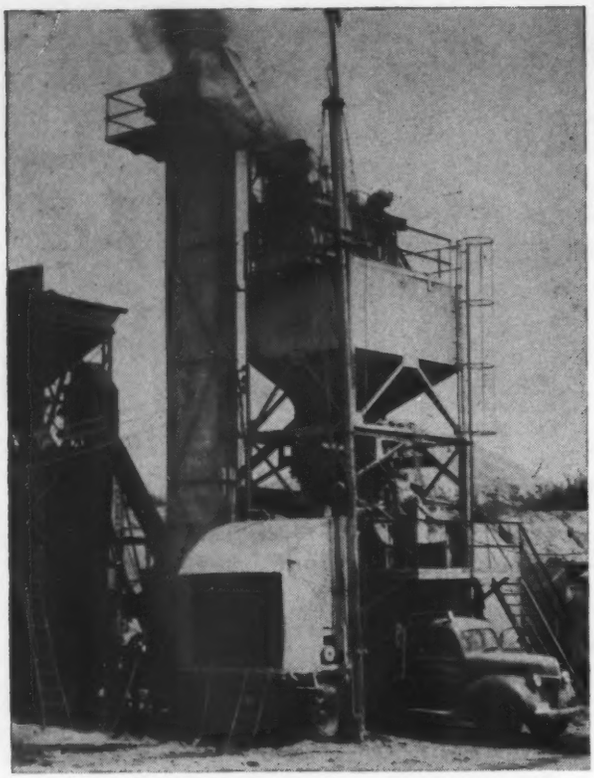
By FRED W. KIMBLE

Bituminous Engineer, Bureau of Construction, Ohio State Highway Department

weighing from 8 to 10 tons. Previous to the recent war emergency all widenings, using hot mix bituminous concrete, were constructed with steel side forms to support the outer edge. During the war, steel side forms were not available, and a stepped construction at the outer edge of the widenings was used. If a 24-inch widening was to be built, the insulation course and first 3-inch base course was built 30 inches wide, the second 3-inch base course 27 inches wide, and the leveling and surface course extended 24 inches beyond the old pavement. Very good results have been experienced from this method, and it will probably be widely followed in the future. When steel side forms are used they must be thoroughly staked and braced to keep them in line, as tremendous lateral pressure on the form is developed during the compaction process. It is difficult to brace steel side forms to prevent lateral movement, which when it occurs is accompanied with vertical movement. During the last two years that steel side forms were used a highly satisfactory method to hold the steel forms was developed. After the form was set and staked a motor grader pulled the freshly



Steps in widening—trench completed, aggregate and mix placed; rolling.



A hot-mix plant in operation.

excavated earth to the back of the form for a space of 1½ to 2 feet wide and about flush with the top of the form. The grader also partially compacted the earth, as the drive wheel passed over it, and by this treatment the forms remained securely in place. Widenings of bituminous concrete are always finished ¼ inch above the old pavement. This is done to compensate for the resiliency in the widened area and for the further compaction secured in finishing the leveling and surface courses. It is necessary to follow this procedure to prevent cracks forming in the leveling and surface courses, at the junction of the old pavement and the widening as they are being rolled. Widenings are never constructed less than 1 foot in width and they are often varied in width, above the minimum, from side to side of the pavement to improve alignment.

Leveling and surface courses are placed with self-propelled bituminous pavers. The three makes in common use are Jaeger, Barber-Greene and Adnun. Operation of the paver is coordinated, as nearly as possible, with plant production so that the placing of hot mixes is nearly continuous. This practice gives a more uniformly dense mat, free from surface scuffing and irregularities, than an intermittent operation. Immediately after a course is screeded and before compaction is performed all surface imperfections or irregularities are corrected. Because of the skill acquired, by many years of practice, Ohio contractors are able to perform the laying operation with practically no hand work. Since a machine finished surface is quite superior to any hand raked surface, hand raking is only allowed in areas that are absolutely inaccessible to paving machines. Consequently paver operators have become so skilled that nearly all intersections, approaches, and incidental work is performed with pavers. Where hand raking is necessary the hot plant mix must be dumped from the truck on steel dump boards and placed, as the raker needs it, with shovels. Immediately after a surface is screeded and surface imperfections corrected, the initial compaction is performed. Rolling progresses continuously, speed of the rollers being kept under 2 miles per hour. Finish rolling is performed as the temperature in the mat permits, which is determined by atmospheric temperature. On cold days the interval between the initial and finish rolling is very short and on hot days in the summer may be as much as two to three hours. Immediately after the initial rolling each course is straightedged and irregularities in the surface marked and corrected while the temperature of the mix permits it to be shifted with a roller. Usual procedure is to begin the rolling at the outer edge and proceed toward the crown, lapping each successive pass half the width of the rolls. This procedure is varied somewhat when a joint is being made against a previously laid course. When a joint is being made, the joint is rolled first. In order to facilitate crown correction all pavers are required to have an indicating level attached to the screed which can be set for the crown desired.

Two rollers are required on each project and as many additional rollers as are necessary to meet the minimum roller requirement, where large tonnages are being placed. Present specifications require one three-wheeled finishing roller weighing 10 tons and one tandem roller weighing from 8 to 10 tons. Additional rollers may be of either type as long as one type does not exceed the number of the other type by more than one. The three-wheeled finishing rollers are generally used to secure the initial compaction and the tandem rollers for finishing. Rollers are required to have minimum dimensions of roll width and diameter, and in the case of three-wheeled finishing rollers a minimum lap of compression and steering rolls. Since the surface tolerance allowed in the finished pavement is ¼ inch in 10 feet, the wheel bases of rollers are required to be slightly in excess of 10 feet. The maximum capacity of rollers is set at 30 tons per hour per roller.

As all resurfacing projects are built under traffic it is necessary to construct joints between adjacent lanes. On two-lane construction, work usually proceeds for one day in one lane and the following day in the adjacent lane. Because of the time interval, the material laid in the first lane has cooled to atmospheric temperature, and traffic has to some degree rounded off the edge of the mat against which the adjacent lane is to be placed. Therefore, the construction of a satisfactory well bonded joint requires skill. Securing a good joint starts when the first lane is laid. It is recommended that when this lane is placed the edge

(Continued on page 37)

Method of rolling center joint.

Growth and Distribution of Film in Percolating Filters

Abstract of a paper before the Institute of Sewage Purification, England, by T. G. Tomlinson, Dept. of Scientific and Industrial Research, Water Pollution Research Laboratory, Watford, Herts.

IN most cases the accumulation of film in the interstices of percolating filters during the colder months of the year limits the rate at which liquid can be applied to the filter. Investigation of the processes by which film accumulates and is disintegrated is, therefore, of practical importance, and the methods and results of such an investigation made at the Minworth filters (See *Sewerage Digest,* February, 1946) are described in this paper.

The rate at which film accumulates or is removed is controlled by three main factors—(1) the rate of growth of the component organisms of the film and the deposition of sewage solids; (2) the breakdown of the film by scouring metazoa, mainly worms and insects; and (3) the scouring action of the liquid flowing through the filter.

Seasonal variation in concentration of film at the surface of single and alternating double filters was studied by placing in the surfaces of the filters cylindrical vessels 6½ in. in diameter and 4 in. deep, with perforated bases, filled with smooth pebbles 1 in. in size. The filter metazoa had free access to the vessels through the perforations in the base and through the surface of the medium. Four of these vessels were placed on Filter A (single filtration); three sets of four vessels each were placed on Filters C and D (alternating double filtration) and one set was changed from sewage to effluent and vice versa every three or four days, another set every seven days, and the third set every fourteen days.

Fig. 1 shows the variation throughout the season in the weight of film accumulating in the vessels on Filters A, C and D with three different periods of alternation. The seasonal incidence of the Diptera *Anisopus fenestralis* and *Psychoda alternata* in C and D during the latter part of the period are shown by the curve (e); and (f) shows the variation in temperature of sewage treated.

In Filters C and D, film accumulated during summer and autumn, when the average temperature of the sewage was 17° C, at an average rate about three times that during winter, when the temperature was 11° C, as shown by the table.

Average rate of increase in weight of film in vessels receiving settled sewage during the periods Sept. 30, 1940 to April 20, 1941, and June 23 to November 24, 1941.

Increase in weight of film (gm per day)

Period of alternation (days)	*Sept. 30, 1940 to April 20, 1941*	*June 23 to November 24, 1941*
3½	7.55	23.1
7	6.00	20.0
14	7.25	19.1
Average temperature of sewage	11 C°	17° C

In Filter A the amount of film accumulated varied generally inversely with the temperature. The reasons for the difference in behavior of A from that of C and

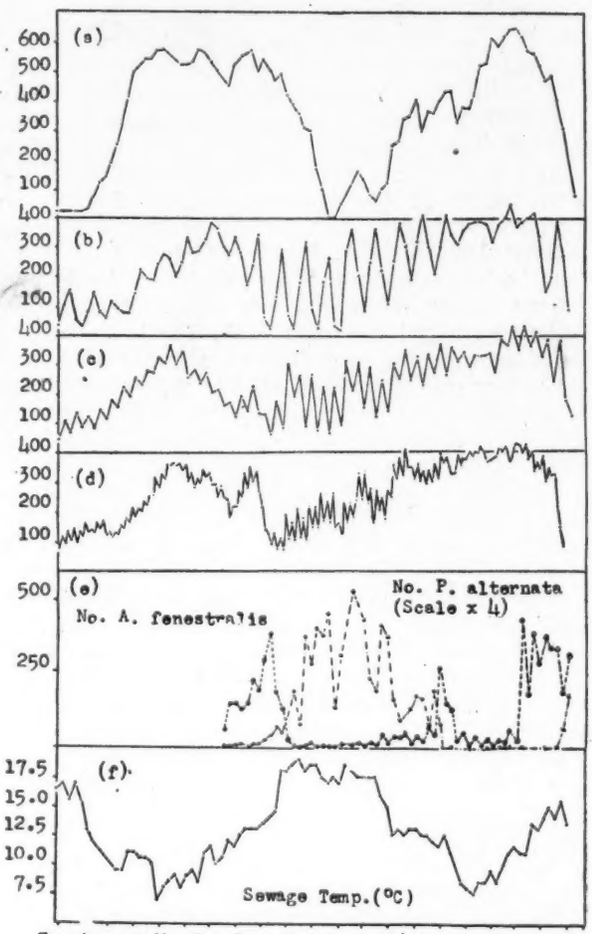


Fig. 1. Film weights and other data; (a) single filtration; (b) (c) (d) alternating double filtration.

D have not been precisely determined, but it may be attributed to the much greater rate of application of sewage to the primary filter than to the single filter, which may be accompanied by a decreased metazoal activity during the primary period.

To determine the rate of growth of film in the absence of scouring organisms, vessels were placed on Filter A, similar to those described above, but with fine wire gauze so placed on the top and bottom that no flies or scouring organisms could enter. In general, the results showed that, in the absence of scouring organisms, the rate of accumulation of film at the surface of a filter receiving a continuous supply of sewage during the winter is about one-half the rate during the summer.

The principal components of the film on the surface of a filter are the mycelium of various fungi, zoogleal masses of bacteria, and sludge precipitated from the sewage. Fungus mycelium has also a secondary effect on the growth of film by its action in straining out

and retaining solid matter from the sewage. The temperature-growth relations of a zooglea-forming bacterium and of the two fungi *Sepedonium* and *Ascoidea rubescens* were investigated, and it was found that the most favorable range of temperature for the growth of the former lies between 10° and 15° C; and for the latter 15° to 25°, at which temperature the rate is about twice that at 10°.

To study the composition and vertical distribution of film in these filters, two perforated earthenware pipes 12″ in diameter were set in each filter, reaching from top to bottom, and in each pipe were six baskets 10″ in diameter and 12″ deep filled with smooth gravel 1″ to 2″ in size. Each column of baskets received sewage from the distributor at the same rate as the filter. These baskets were removed and examined five times during three years. It was learned that, although Filters C and D together treated 6 to 8 times as much sewage as Filter A, the total amount of film which accumulated in the two combined was only about three times that which accumulated in Filter A. In filters C and D the lower four baskets contained 54% and 58% of the total amount of film, while in Filter A the corresponding baskets contained 43% and 35%. The lower baskets contained a greater proportion of mineral matter than the upper; on the basis of volatile matter only, each of the double filters contained about 50% more film than Filter A, and about 40% of the total film in A was in the top basket, and 24% in the case of the double filters. Microscopic examination showed that fungal growth in Filters C and D extended from the surface to about 3 ft. below, whereas in Filter A it was mainly confined to the top foot.

The decomposition of film during the summer is carried out largely by larvae of *Anisopus fenestralis* and *Psychoda alternata*. The variation in the numbers of larvae in the filters can be judged by the ratios of the numbers of adults trapped during the winter and during the summer at Minworth; these were, *Anisopus fenestralis* 1 : 5; *Psychoda alternata* 1 : 1,000. The decrease in rate of growth of film during the winter is more than compensated for by the decline in population of insect scourers.

Although enchytraeid worms *(Pachydrilus lineatus.)* and Collembola *(Achorutes subviaticus* and *Tomocerus minor)* inhabit the upper layers of the filters in appreciable numbers during the winter, the establishment in the Minworth filters of a favorable balance between the processes of growth and disintegration of film depends on the development of a large population of *Anisopus* and *Psychoda* during the late Spring and summer of each year.

Mills[5] considered that the success of alternating double filtration is due to a large extent to the quick recovery of the filters from their winter condition, and also to the steady discharge of solid matter from the filters throughout the year. Fig. 1 shows that during the critical period the concentration of film at the surface of the single filter was about 50 per cent. greater than at the surface of the alternating double filters. Owing to the more even vertical distribution of film, the alternating double filters were able to carry larger amounts of film without its giving rise to serious obstruction.

The effect of three different periods of alternation on the accumulation of film at the surface of Filters C and D is shown in Fig. 1. The general course of accumulation of film and the maximum weight of film accumulated were similar for the three periods. Observations made over a period of years on the incidence of ponding on Filters C and D when operated with a weekly and with a daily period of alternation showed that there was no significant difference between the two methods as far as accumulation of film is concerned. In experiments on the treatment of milk and whey washings by alternating double filtration, it was found that the process worked satisfactorily when the order of the filters was changed every two or three weeks[6].

It has been pointed out that fungi in filters undergo marked changes when treated with a purified effluent poor in nutrient substances. In general, a change in internal organization takes place, resulting in the formation of reproductive bodies such as chlamydospores *(Fusarium* and *Sepedonium)* and gemmae *(Saprolegnia)* at the expense of the vegetative mycelium. Starved fungus mycelium, in particular the portions of hyphae denuded of protoplasm, is particularly vulnerable to attack from bacteria. Fragmentation of hyphae following bacterial decomposition is probably an important factor in the dispersal of film during the secondary stage of alternating double filtration when periods of alternation of one to three weeks are employed.

Heukelekian[4] considered temperature and load as important factors tending to increase the quantity of film in a filter, and that the flushing velocity of the sewage was not effective in removing film from a filter. Load is defined as strength of sewage treated multiplied by the rate of application. The rate of growth of film depends on the strength of sewage, quite apart from the rate of application; the rate of growth of film in a vessel supplied with settled sewage was about five times the rate in a vessel supplied with the same volume of a mixture of equal parts of settled sewage and settled filter effluent.

It seems probable that the amount of dilution would account for the difference in amounts of film at the surface of the bio-filter and of the single filter. The recirculation ratio employed by Heukelekian in the bio-filter was 1.5, whereas, in the case of the experiment on Filter B, Minworth, described above, a ratio of 1.0 was used. All the solids discharged from a filter are carried through the filter by the washing action of the liquid treated. The film in the Minworth filters was composed largely of particulate matter such as sewage sludge and dejecta of scouring organisms. This type of material is liable to be washed through the filter, and its accumulation must depend to some extent on the flushing velocity of the sewage. The fungi, because of their long hyphae, and the zoogloeal bacteria, because of their adhesive character, are able to grow in the filter and withstand the scouring action of the sewage.

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Effect of Frost Conditions on Load Carrying Capacity of Pavements

The advent of airplanes having wheel loadings many times greater than the heaviest truck wheel loadings on today's modern highways, has created serious problems in the design and construction of airport pavements. Under a nation-wide War Department program being administered by the Corps of Engineers, the Detroit District Engineer Office has for several months been conducting tests at Selfridge Field, Michigan, to determine the effect of frost conditions on the load carrying capacity of these pavements. Data resulting from these tests and field investigations will be used to improve and develop fundamental design standards.

Traffic load tests were made with special equipment designed by the Corps of Engineers which duplicated the loading of heavy bombers. Wheel loads up to 60,000 pounds on a dual wheel assembly were used. During tests which were started on March 2 and completed on March 25, this equipment was pulled over one area 15 times daily to simulate the capacity operation of a B-29 on a runway, and was pulled over another area 45 times daily to simulate the capacity operation of a B-29 on a taxiway.

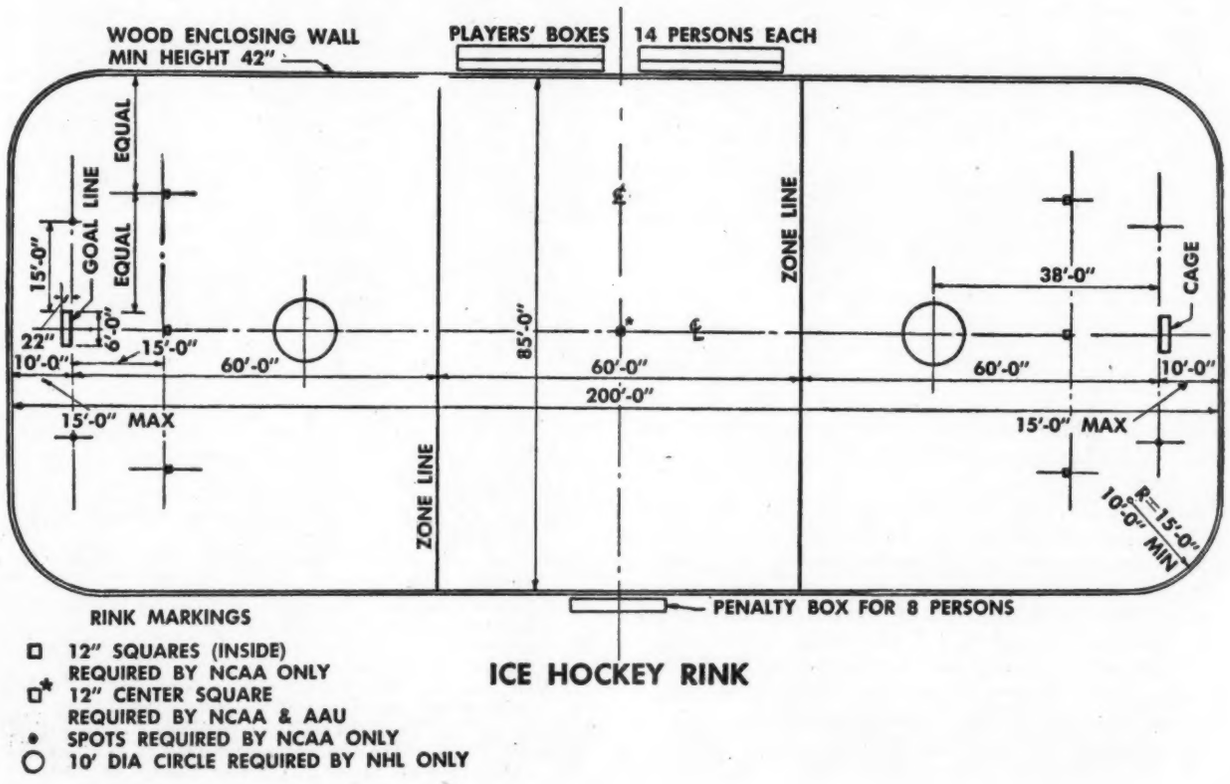
Two large water filled tanks supported by 10" I-beams on each end of a 30-foot I-beam, were used as the resisting force to apply a 100,000-pound pressure on the corner of a 10 inch concrete apron slab. A 50-ton hydraulic jack set on a 24-inch diameter steel plate was used to measure the deflection in the concrete under various soil conditions as a result of applying certain pressures.

The frost investigations not only involved traffic load tests but required detailed research and tests of the many factors that affect the pavement strengths, such as ground water elevations, foundation material, and the amount of heave in the pavement due to the formation of ice lenses in the underlying soil during frost periods.

In carrying out these tests, Army Engineers constructed eight thermometer wells below the pavement, with depths varying from one to eight feet, to record subsurface temperatures. Also, numerous test pits were excavated through the 10-inch pavement to the depth of the water table to obtain moisture and density samples of the soil and to follow the frost level down into the subgrade and back to the surface again. Numerous photographs were taken to study the ice lenses in the subgrade soil. Theoretically, if all the thicknesses of the minute horizontal ice lenses could be added up, the total thickness would equal the amount of heave in the pavement due to frost, which this year reached a depth of 2.9 feet below the surface of the pavement.

Another test which the Detroit Engineer District

Layouts of Playgrounds and Athletic Fields



made consisted of taking periodic readings of twenty-two ¾-inch galvanized iron pipe wells for ground water elevations and elevation of water in the base material under the pavement in an effort to determine subsurface drainage conditions. Since Selfridge Field is completely tiled, it was possible to isolate sections and determine the subsurface flow for a certain area by measuring the flow into certain manholes and catch-basins.

Information compiled by the Detroit Engineer District from these investigations is expected to be utilized in the proposed revision of the Airfield Pavement Design and Airfield Drainage Design sections of the Engineering Manuals prepared by the Chief of Engineers, Washington, D. C.

Leaking Clay Core Wall

(Continued from page 20)

ture content and weakness at the time of examination were partly caused by re-wetting when the water level was being raised.

For drying out to have occurred down to this depth (5 to 10 ft.) in a bank where the fill adjacent to the core-wall is generally tight is not altogether inexplicable when it is realized that seasonal variations in moisture content may extend down to at least six feet in heavy grassland[4]. In this case drying out was aggravated by the exposed nature of an embankment, by the fact that plant roots were being driven down by the five years of lowered water level, and by the presence of slickensides ready to open into fissures which would accelerate the rate of drying and of root penetration.

(4) The formation of the hard upper zone.—Some of the clay in this zone has never been below the normal water table in the core-wall, and consequently has not undergone anaerobic decomposition and color change. Its drying out and cracking have been going on for many years, and the lowering of the zone due to settlement may have contributed slightly to the leakage.

Having given some account of the partial failure of this particular core-wall, and discussed some of the factors involved, it is of interest to relate the findings to the general use of puddle clay. Smiles[5], Telford[6] and Binnie[8] considered this subject. Rankine[9] has stated that the proper material for puddle is "clay . . . containing as much sand and fine gravel as is consistent with its holding water; if there is too little sand, the puddle is likely to crack in dry weather." Parker[10], Strange[11] and Wegman[12] generally confirm this.

This investigation indicates that the Atterberg limits are an important indication of the suitability of a clay. Briefly, the liquid limit is the moisture content at which the clay ceases to be plastic and becomes fluid; the plastic limit is the moisture content at which, on drying, it ceases to be plastic and becomes crumbly, the moisture content being measured as a percentage of the dry weight of the clay. (For details of the method of measurement, etc., see a standard textbook on soil science or soil mechanics.) Values depend on the type of clay, both on its grain size distribution and on the clay minerals of which it is composed. A silty clay will have low liquid and plastic limits; they will increase through the range of fat clays, and for an active colloidal clay such as bentonite will be very high indeed.

As the consistency of a puddled clay is determined by the relation of its moisture content to its Atterberg limits, of which the liquidity index is a measure, it is clear that a fat clay, with high liquid and plastic limits, will, in its puddled state have a higher moisture content than a lean or silty clay whose Atterberg limits are low. In this particular core-wall, the relatively soft puddle in zone 1 with liquid and plastic limits of 130 and 45 respectively had a moisture content of 80 per cent, with a liquidity index of 0.41. On the other hand, freshly laid puddle of London clay, in a more plastic condition, was found to have a moisture content of only 45 per cent, but its liquid and plastic limits were 71 and 23 respectively, and the liquidity index 0.46. In zone 3, where the high liquid limit clay has still a moisture content of 60 per cent, it was hard and stiff.

Being plastic and tenacious when freshly puddled, the fat clay may appear to be superior to a leaner clay, but the observations of Macey and Hvorslev's results indicate that the thixotropic loss in plasticity will be greater in a fat clay.

Fig. 2 shows the relative ranges of shrinkage. It will be seen that for a fat clay puddled at a moisture content of about 85 per cent the shrinkage on complete drying out is represented by the part of the curve from A to B, a decrease in volume of 59 per cent. For the lean clay puddled at 45 per cent moisture content, the shrinkage is represented by CD, a decrease in volume of only 35 per cent.

It is worthy of note that another large storage reservoir built about 1920 with a London clay core-wall in a relatively pervious embankment and subject to the same water level restrictions from 1939 to 1945 did not suffer from drying cracks to any degree. The liquid and plastic limits were 76 and 26 respectively and the moisture in the core-wall about 43 per cent.

It is not necessary to emphasize the importance of avoiding the formation of shrinkage cracks in a core-wall, either by the maintenance of conditions favorable to this type of structure, or by the use of a material with a relatively low potential shrinkage. It should be remembered that puddled clay is not in a state of equilibrium either within itself or with the atmosphere, and that the process of drying out is not completely reversible. Re-wetting of the clay can neither restore its original volume nor enable it to recover its plasticity.

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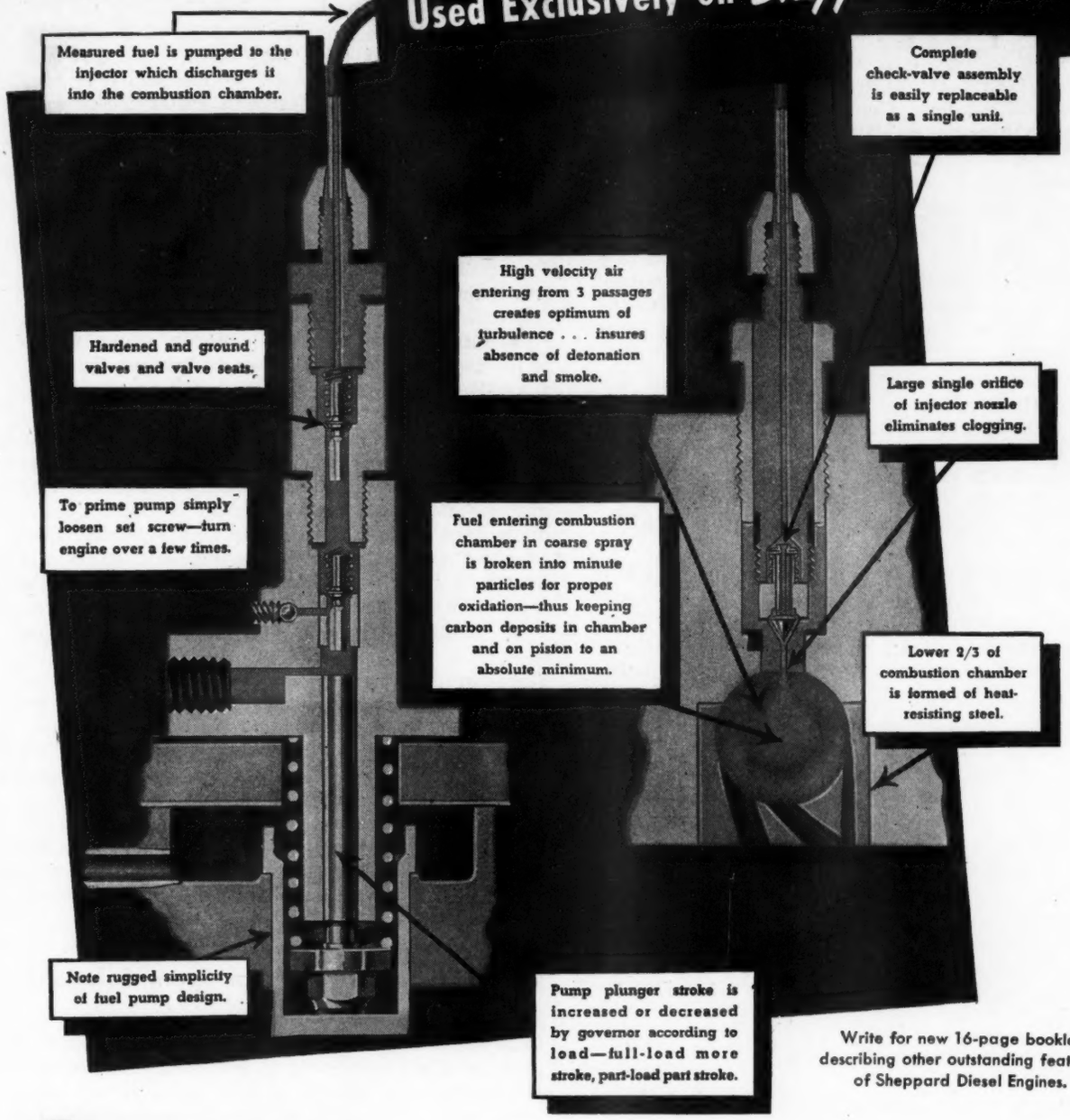
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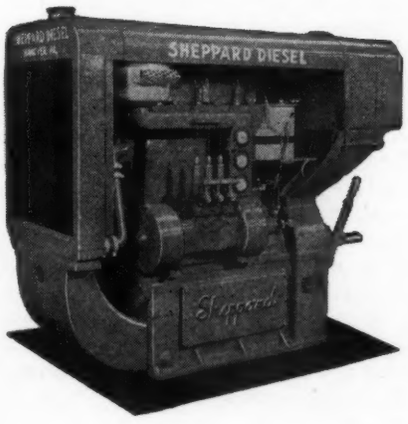

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Infiltration Into Sewers

(Continued from page 25)

continuous heavy stormy periods; found GK and cement with Weston collar effective. Ravena "uses transite pipe on all new work and finds it very effective." Suffern, infiltration is about 100,000 gpd.

In Asheboro, N. C., infiltration is variable, being large in some old lines; use GK and Sanitite. Roxboro, N. C., says "infiltration takes up half the capacity of the sewers."

Akron, O., reports infiltration to be 20% to 100% of dry weather flow. Columbus has a "substantial amount at times but no data as to volume." In Cuyahoga Falls, the flow of sewage to the treatment plant represents 87% of water consumption. Lima has only 8% infiltration and Steubenville 2%.

Bartlesville, Okla., "estimates 5,000 to 10,000 gals. average per mile of sewer per day." Tulsa "uses clay pipe jointing compound and considers good cement joints second best; how much infiltration is the $64 question." Hood River, Ore., has "considerable water from roots."

Lower Merion Township, Pa., has "a sewage flow of 136 gallons per capita, including infiltration, which is less than 1000 gals./acre/day; use premolded asphalt joints." Ellwood City, Pa., reports infiltration "considerable in older lines; on last job used Weston gasket with poured grout and the leakage was less than 10,000 gals./mile/day." Northampton, Pa., 100,000 to 200,000 gpd.

North Providence, R. I., estimates infiltration to be 1.7 mgd for 40 miles of sewers. In Alcoa, Tenn., infiltration is 100% of normal flow. Dyersburg, Tenn., "infiltration not known; interested in poured joints." Knoxville, Tenn., "150 gals./acre at zero population, and 1200 gals./acre at 35 population/acre."

Highland Park, Tex., reports infiltration is "sometimes several times normal flow; use soil pipe with lead joints in bad places." Temple, "an awful lot." Tyler, "20,000 gals./mile/day; total sewers 77.2 miles." Waco, "over 100% of normal." Wichita Falls, "flow will increase 100% during heavy rains; have been using an asphalt composition joint recently."

Wauwatosa, Wisc., "uses Weston gasket; not much infiltration normally; foundation drains are connected to sewer system and in rainy weather a single residence increases from 150 gals./day to as much as 40,000 gals./day." Wisconsin Rapids reports infiltration 150% to 200%; has "used hot poured joints in late construction."

Design and Capacity of Gutter Inlets

PROFESSOR N. W. CONNER
North Carolina State College of Agriculture and Engineering

IN ORDER to secure information on the performance of inlets, the city of Raleigh and the North Carolina State College Engineering Experiment Station undertook a joint research project. The purpose of the investigation was twofold: first, to determine the capacity of the several types of inlets in use when installed on various grades, and second, to study the hydraulic principles involved whereby improvement in inlet design could be effected, especially on steep grades.

The apparatus used in the study of inlets was located on a hill sloping down to a small creek. It consisted essentially of a half section of street with a concrete gutter and curb on one side. The section was of standard design and full scale. The length of the test section was 110 ft. and it was so designed that the street level could be adjusted to any grade between 0 and 10 per cent. Water was supplied to the test section by means of a 6-in. pipe connected to a 14-in. city main.

Three types of inlets were tested. Those of the first type were plain rectangular openings in the side of the gutter. All of them were 6 in. high and had lengths of 1, 2, 4, 5, 6, and 7 ft. The second type of inlet consisted of side inlets with grates. There were two of this type tested, each 2 ft. long and 6 in. high with a grate 24 in. by 24 in. One grate was made with 7 bars, each 1¼ in. wide and 2½ in. thick, perpendicular to the length of the inlet. In the other grate the bars were 2 in. high and ¾ in. wide. These bars were placed at 45 deg. with the inlet and inclined at 45 deg. The grates were of course flush with the bottom of the gutter. Inlets of the third type were of the deflected flow class. Side inlets 2 ft. long and 6 in. high were used with various deflecting vanes placed in the gutter to cause the water to flow into the inlet.

The procedure followed in testing the inlets was to measure the capacity of each inlet in cubic feet per second on grades of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 6.0, 8.0, and 10 per cent. A study of the data shows that plain side inlets can be satisfactory even at steep grades. The effect of increasing the length is greater in the larger lengths and at the higher grades. Thus on a two per cent grade, increasing the length of the inlet from 6 to 7 ft. will result in almost double the capacity of the inlet change from 1 to 2 ft.

The conclusion that the grate type of inlet is most efficient at low grades and becomes less effective at higher grades was borne out by the tests on this type.

The use of deflecting vanes to make the water flow into the side inlets proved highly satisfactory.

One of the side inlets with grate gave the best over-all performance. The inlet was 2 ft. long and had a 24 in. x 24 in. grate. The bars of the grate were set at 45 deg. with the curb and also inclined at 45 deg. This inlet, when used on an 8 per cent grade, discharged 290 per cent more water than did the same size inlet with conventional bars.—*Highway Abstracts.*

Recovery of Silver From Spent Solutions

A large amount of silver is lost continuously in the form of spent photographic solutions. The silver in these solutions is present at low concentrations with an overwhelming amount of other salts, mainly hyposulfite with which it forms complex compounds. The recovery of silver from these solutions has been attempted in several, rather expensive ways.

A new method has been developed in the chemical laboratory of the Timber Engineering Company, Washington, D. C. according to Dr. E. Farber, Chief Chemist. It is based on the use of a specially prepared lignin, called Teco-Lignin S, and is quite simple in operation. A small amount of the Teco-Lignin S precipitates the silver in the form of a quickly settling sludge from which the metal or its salts can be easily prepared. The precipitation can be carried out in most any photographic shop. The silver-rich sludge can then be sent to a recovery plant.

Other valuable metals can be salvaged from dilute, impure solutions in similar manner.

Labor and Materials Adjustments in Recent Dam Contracts

The Bureau of Reclamation, in an attempt to minimize the uncertainty of labor costs to contractors on the Davis Dam project, has agreed that, on all labor performed more than 180 days after the date of contract, the contractor will receive payments adjusted to compensate for the upward or downward changes in the costs of labor. The amounts due under the contract will be adjusted to the amount of 65 per cent of the difference between the total amount of wages actually paid to laborers and mechanics employed under the contract and any subcontract and the total amount of the wages that would have been paid had the labor rates not been changed.

Complete Strawboard Waste Pilot Treatment Plant

A complete pilot plant equipped with a Permutit precipitator and a high rate trickling filter has been made available to the National Council for Stream Improvement strawboard waste project at Purdue University by the Terre Haute Paper Company. This plant will be operated under Professor Bloodgood's direction for the purpose of determining the efficiency of the precipitator for removing suspended solids from the waste and the filter for oxidizing dissolved organic matter. Experimental work reported in the literature and preliminary studies at Purdue University indicate the possible successful applicability of such treatment. The Council will operate the plant for a six month's period.

Driving Steel Sheeting

For driving steel sheeting, a convenient steel driving head, weighing about 75 pounds, and with corrugations to engage the top of the sheeting, gives protection to the driving edge. The sheeting can be driven either with a hand maul or by using an air or steam power hammer. Small, fast action hammers generally tend to peen the top edge of metal sheeting until it is difficult to remove the driving head. A slow heavy blow sufficient to overcome the inertia of the sheeting with enough excess energy to penetrate the soil has been found more satisfactory. Such a blow should be not less than about 200 foot-pounds, from a hammer delivering not over 500 blows per minute, with a length of stroke of 5 to 6½ inches, and with striking parts weighing from 25 to 40 pounds, depending on the depth to be driven and the soil.

Ohio Highway Construction

(Continued from page 30)

against which the joint is to be made is kept to as true a line as possible, and that it be tamped with the back of a rake before the rolling operation, to make the edge as nearly vertical as possible and help consolidate the material. In laying the successive lane some lap of the paver screed will be found necessary and sufficient loose material must be left so that the mat will compress to the depth of the first lane or slightly above it. A skilled raker is necessary properly to set up the joint at the right point for finishing. Joints are rolled immediately behind the raker, the first pass of the roller being almost entirely on the

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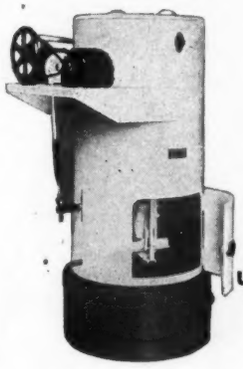

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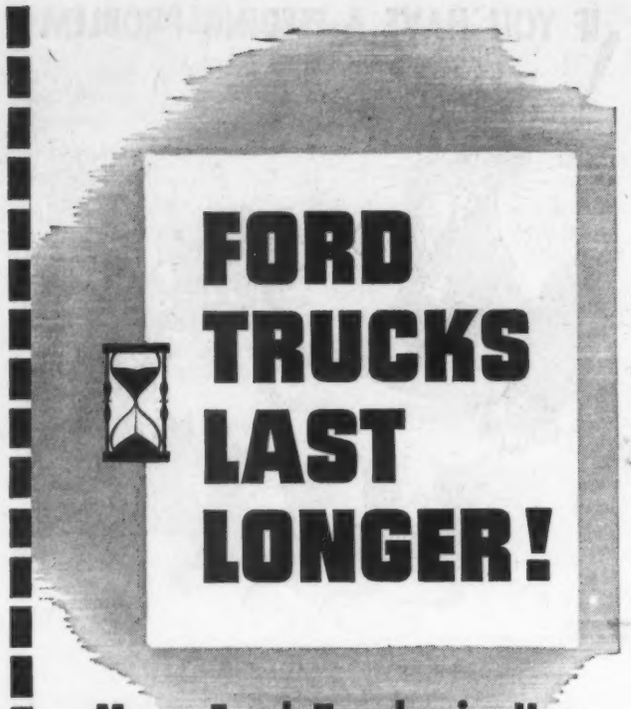

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previously laid lane with only two to three inches on the new material. By this method additional pressure is secured and with the proper amount of material a well bonded and dense joint is made. Joints in the surface course are always placed at the centerline of two-lane pavements and evenly spaced across the width of a multi-lane pavement. Joints in the leveling course are set to one side of the surface course joints at least 6 inches.

Resurfacing city streets presents some additional problems that are not encountered on rural highways. It is necessary to raise catch basins, manhole frames, valve and monument boxes. These devices are loosened before laying the leveling course. After the leveling course is finished the castings are reset to grade and the space around them either filled with Portland cement concrete or thoroughly compacted bituminous concrete. Surface course is then laid over the pavement and finished. Before finishing it is always necessary to remove the small amount of hot mix, left on the casting by the paver, and dress the edge. By this method a slightly one-piece surface is accomplished without patches. The surface course is always finished approximately ¼" above the castings. In some cases manhole frames have been raised with adjustable concentric rings welded in place. Surface courses in urban areas are usually constructed of the finer surface course mixture.

This discussion has mainly covered Ohio's intermediate grade hot mixed bituminous concrete which is designated as T-35 and closely corresponds to Bureau of Public Roads "Class I." The bulk of all work done is with this class; however, a higher type where a finishing machine operates on forms and with closer grading control is sometimes built. The asphalt cement used is usually 85-100 penetration, 70-80 penetration being used on high traffic density pavements. In 1945 approximately 1,000,000 tons were manufactured at an average cost of $10.72 a cubic yard in place ready for acceptance.

Schistosomiasis

(Continued from page 27)

water) is satisfactory. Actually, it is probable that considerably less than 1 p.p.m. residual of chlorine will destroy the cercariae. However, most of the tests have been made on *S. haematobium* and *S. mansoni* and it is possible that *S. japonicum* is more resistant.

During the war some progress was made in developing cloth that would prevent passage of the cercariae, but none has been produced so far in quantity. When working or wading in water, protection is afforded only by rubber waders, boots, gloves, etc. Protective ointments have been produced that are of some value but none that can be relied on fully.

Dr. G. W. Luttermoser of the Institute of Inter-American Affairs has been investigating methods for the control of schistosomiasis in Venezuela, where this disease also occurs. He has paid particular attention to the destruction of the snail carrier. In addition to clearing out vegetation to improve the flow in ditches and canals, he has used chemicals. Freshly slaked lime in concentrations of 500 p.p.m. is fairly effective, though some snails survive. Copper sulphate in concentrations of 20 p.p.m. seems to be effective and its use obviates the need for clearing out vegetation and straightening channels.

Direct sunlight, with temperatures of 100° to

113° F, and relative humidities of 50 to 80, will kill the snails and the eggs in an hour. Therefore regular drainage and drying out of areas, with exposure to sunlight and heat, is a method of control.

A DDT-triton emulsion was not effective in concentrations less than about 300 p.p.m. DDT in other forms is being tried out. Increasing the velocity of flow of water to more than 0.4 meter (about 1.33 ft.) per second seems promising in irrigation canals. Use of a filter containing 76 centimeters of sand and gravel was ineffective. A fuller report on this work was published in Revista de Ministerio de Sanidad y Asistencia Social, Venezuela, Feb., 1945, Vol. X, No. 1.

The following list of references to other articles was supplied in a memorandum by Gordon M. Fair of Harvard University.

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(11) T. B. Magath, "Lethal Dose of Chlorine for Cercariae of Schistosoma mansoni," U. S. Naval Medical Bulletin, 40 (1942), 237.
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Ion-Exchange Process of Water Treatment

(Continued from page 21)

ing acids, and the anionic exchangers remove the acids. Raw water is fed under pressure to the first column and thence through the series. The quality of the treated water is indicated by an electrical conductivity cell operating in the outlet from the last column. When the cell indicates that the delivered water is no longer satisfactory, the exchange capacity of the resins has been used up. The resins are then regenerated with dilute solutions of sulfuric acid and soda ash, rinsed, and are then ready for reuse. The cycles of use and regeneration can be repeated indefinitely so that the direct cost of operating the unit involves primarily the cost of the regenerated chemicals.

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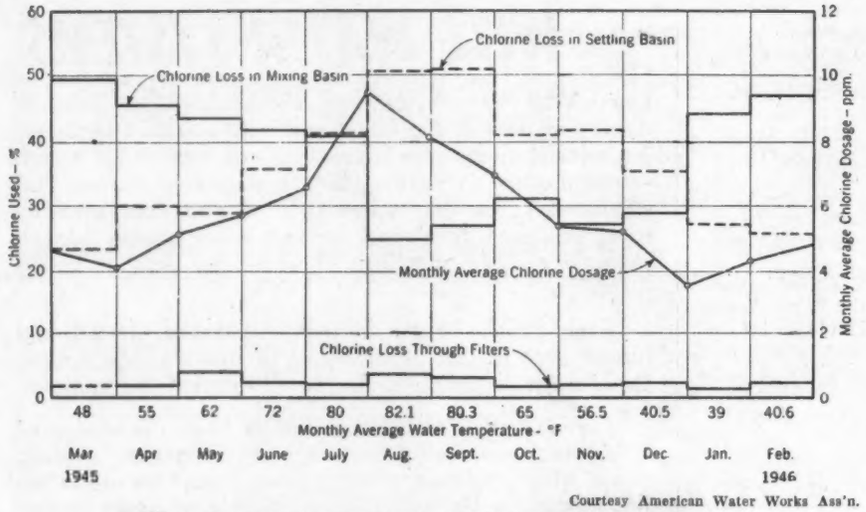
In this section are digested and briefed the important articles appearing in the periodicals that reached this office during the previous month. Appended are Bibliographies of the principal articles, in which the articles in each periodical are numbered consecutively throughout the year, beginning with our January issue.

The letter and number at the end of each digest refer to those used in the Bibliography. Numbers not found in the current Bibliography will be found in the one published the previous month.

The Waterworks Digest


Chlorine Loss in Settling Basin
Chlorine Loss in Mixing Basin
Monthly Average Chlorine Dosage
Chlorine Loss Through Filters
Chlorine Used - %
Monthly Average Chlorine Dosage - ppm.
48 55 62 72 80 82.1 80.3 65 56.5 40.5 39 40.6
Monthly Average Water Temperature - °F
Mar 1945 Apr May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. 1946

Courtesy American Water Works Ass'n.

Effect of seasonal temperature variations on chlorine demand.

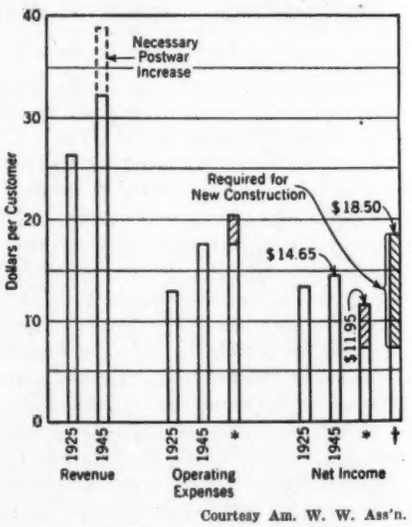
Odor Control by Residual Chlorine

The Ohio river at New Albany, Ind., received wastes from TNT, synthetic rubber and powder plants that made it difficult for that city to furnish water satisfactorily free from color, taste and odor. After some experimenting it was found that this could be effected by free residual chlorination, but the amount of chlorine required was high—dosages as high as 30 ppm with resulting residuals of 24 ppm being used. When applying chlorine, the tastes and odors became progressively worse until the point of free available chlorine residual was reached, when the tastes and ordors disappeared. TNT wastes were colorless until sufficient free available chlorine was present, when they changed to a colored and insoluble form and settled out in red clumps within 48 hr. Synthetic rubber wastes, believed to include benzol, ethyl benzine, ethyl alcohol and aldehydes as well as butadiene and styrene, were removed completely. In addition, the growth of algae in the basin used for settling after chemical treatment was controlled; flocculation was aided; the lactose-fermenting organisms were practically eliminated; and this treatment produced a saving in chemical costs. Practically no chlorine taste developed, but there were slight odors from water just drawn from spigots, escaping as the pressure was suddenly lowered. It is not implied that by use of free residual chlorination all other methods of removing tastes and odors can be dispensed with.

The free available chlorine apparently reacts in one of three ways: 1—Oxidation of the waste products having taste and odor to soluble tasteless and odorless products. 2—Oxidation of such waste products to products insoluble in water. 3—Volatilization of the taste-and-odor-producing substances, using as a vehicle the volatility of nitrogen trichloride, one of the end products when chlorine is added in excess to water containing ammonia.[A73]

Supplying Water for Federal Housing Program

A study of inventories of water systems in cities of over 10,000 population, representing 75% of the buying power of the industry, shows that "today they stand unable to carry on the postwar construction program they had planned; unable to catch up on the maintenance work they patriotically withheld during the war; and apprehensive that the Congress will authorize the National Housing Program without clearing the way for price adjustments which will permit manufacturers to produce the things they need." How serious the problem is will be shown by the following condensed tabulation of nine classes of materials used in water distribution—the type of material the industry cannot do without and still serve new housing areas. The first column shows the number of weeks' supply the industry carried in 1940; the second column the number of weeks' supply on hand April 1, 1946; and the



Courtesy Am. W. W. Ass'n.

Necessary increase in revenue.

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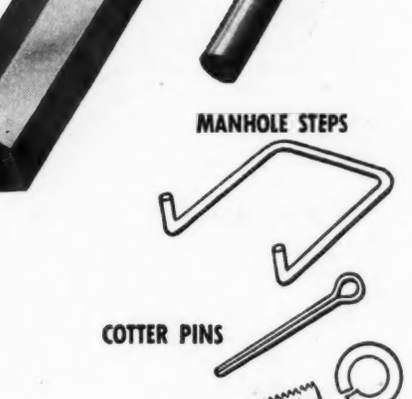

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third column the number of weeks' wait the manufacturers state will be necessary before the material on order can be produced and delivered.

	1	*2*	*3*
Pipe	28	9	16
Fittings	55	10	14
Valves	26	10	14
Hydrants	23	11	15
Valve boxes	23	8.5	14
Curb boxes	23	7.5	15
Service line materials	30	9	16
Service line fittings	47	9	17
Meters	15	10	15

There is but one expression that characterizes the situation. The water works industry is moving toward a complete tail-spin in its ability to carry on even its *normal* activity. Every executive in the water works industry wants his city to do its part in the housing program. But this industry cannot contribute its part to the national housing program until the conditions which limit production of its construction and maintenance materials are recognized by those in authority and then forthrightly cleared away.[A80]

Costs and Rates In Canada

The average cost of waterworks systems in Canada has been computed to be $4.83 per capita per year, the debt charges being $2.14. The charges for water supplied have generally been between 8 and 15 ct. per 1,000 gal., averaging 13.75 c.

Charges for public fire protection service vary from nothing to $231 per hydrant, averaging $40.42 per hydrant. On a per capita basis the charge varies from zero to $5.96 per capita, averaging 46 ct. Of 91 Ontario municipalities, 12 derive no revenue for fire protection, 65 use the hydrant rental basis, the remaining 14 some other basis. In Ontario, all publicly owned utilities are exempt from municipal taxes, but Calgary and Saskatoon each pay about 5% of its total revenue in lieu of taxes. In Windsor, 1.5 mills on assessed valuation of property is charged for fire protection, equivalent to $68.60 per hydrant. At Peterborough, 1/3 of the cost of operation (exclusive of purification) is charged for fire protection, or approximately 15% of the total revenue.[M12]

Iron Makes Zeolite Softening Difficult

The supply of Willowdale, Ontario, is from a deep well 2½ miles from the filtration plant, to which it is carried in a 12" c. i. pipe. The water contains 1.4 ppm of iron and 300 ppm of hardness. Two-thirds of it was softened in two 200 gpm zeolite softeners to zero hardness, mixed with unsoftened water, and water delivered at 100 ppm hardness. But as consumption increased, more unsoftened water had to be used until the average hardness rose to 250 ppm. Also it was difficult to remove the iron, which accumulates in the zeolite beds and reduces their efficiency and capacity. Iron which left the well in the ferrous state became ferric in the 2½ mile pumping main. The solution of the problem is to remove the iron by aeration and filtration before softening. A small plant is being installed for experimenting on the softening of the supply by the lime treatment method, using a spirator designed to operate on water at 50° temperature or higher. Contract has been let for four additional zeolite units to deliver 1,000,000 gpd of 80 ppm in water.[M11]

Financing Main Extensions

Belmont, Mass., until 1927 financed its main pipe extensions by requiring a real estate developer to guarantee an annual return of 6% of the cost of laying an extension for him. This barely covered interest and the cost of the water, leaving nothing for repayment of bonds or for maintenance. Under this plan the water board was getting deeper in the red each year, and a new plan was adopted. Under this, if an extension was made for one or more individual applicants they must guarantee 10% of the cost of the extension for ten years. In the case of subdivi-

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sions of land for development, promoters must pay in advance 75% of the estimated cost of laying a 6" pipe (later changed to 8") in all streets to the limits of the development. In 1937 the 10% guarantee for individuals was eliminated and the 75% prepayment applied to all extensions. If the developer wishes to do the excavating and backfilling of trenches himself, the cost on which his payment is based may be reduced by not more than 30 cts. per lineal foot of trench. Since 1926, $91,000 has been collected from real estate developers toward financing main pipe extensions.[B5]

Confirmatory Media In Bacteriological Tests

"Standard Methods of Water Analysis" says that, for a confirmed test for presence of the coliaerogenes group of bacteria, brilliant green lactose bile, crystal violet lactose broth, fuchsin lactose broth and formate ricinoleate broth all have equivalent value. The author questioned this and during 1945 ran 1811 tests, using each of the 4 confirmatory media in each test. Of these tests, 330 showed at least one positive presumptive tube. The percentages showing positive confirmation varied widely between the different media, and those showing coliform indication even more so, varying by as much as 100% in the annual average and 700% in the monthly averages. It is therefore evident that, from a practical viewpoint, the four liquid confirmatory media are not truly equivalent. In the next edition of Standard Methods, brilliant green lactose bile broth alone will be offered as an acceptable confirmatory medium.[F29]

Des Moines, Ia. Infiltration System

Des Moines obtains its supply of 17.2 mgd from a gallery 18,264 ft. long laid parallel to Raccoon river and about 100 ft. from the shore. It is composed of concrete pipes 4 to 6 ft. in diameter and 2 ft. long, laid with ¼ in. open joints between pipes, with the top of the pipe about 10 ft. below river low water, surrounded by about a foot of fine gravel. The river valley for at least three miles above the city consists of a bed of coarse sand and gravel lying on an impervious clay and shale bottom. Water from the river filters through this sand into the gallery at the rate of about 220,000 gpd per acre of river bed, and that reaching the gallery compares favorably with the effluent from a good mechanical filter plant. Surface clogging of the sand in the river bed is removed by the occasional floods.

To provide for occasional clogging of the river bed, fifteen flooding basins totaling 65 acres have been provided located from 20 to 100 ft. from the gallery, into which water is pumped from the river, passing through 5 to 15 ft. of clay silt into the underlying gravel. To provide against insufficient flow in the river, a reservoir of 1400 mg capacity has been built on a tributary 5 miles above the gallery.[F33]

Lime Application To Sand Filters

Water for an ordnance works at Tyner, Tenn., was passed through two 2 mgd slow sand filters, about .045 gpg being used. The lime was applied in the clear well of filter No. 1, and in the influent to filter No. 2. In No. 1, small mud balls formed in the sand and a mud blanket on the surface; but in No. 2 there was no mud blanket and only an occasional small mud ball. Later, the lime was applied to No. 1 at the influent instead of the clear well, and after a week there was a noticeable decrease in the number of mud balls, and at the end of two months there were none, and the filter runs had increased from 73 hr. to 100 hr.[G30]

Copper Sulphate For Algae Control

Copper sulphate should be used as a preventive measure rather than a cure. Determine by daily microscopic examinations and counts when the organisms begin growing rapidly in the reservoir, then apply the copper. For each organism there is a temperature (41° to 77°F.) when it begins rapid increase, sometimes tripling in number in one or two days. The amount of copper sul-

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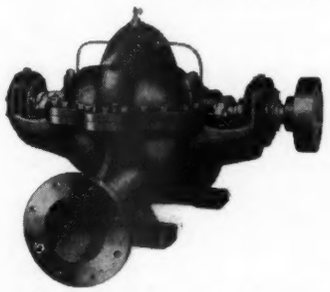

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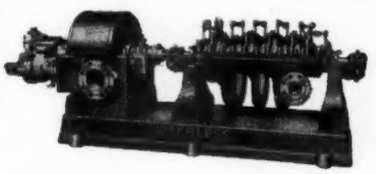

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phate to be used can be determined by a laboratory test to determine that required to increase the alkalinity of the water to be treated. This amount should be distributed uniformly, allowing for the depth of each part of the reservoir (above 20 ft. depth) as well as the area. Applying in strips 40 ft. wide is recommended.[G27]

A Theory of Water Divining

Apparently many in England, even among engineers, believe more or less firmly in the reliability of water divining. A writer to *Contractors Record* (London) says:

"What is the mystery of dowsing? The answer is that it is not a mystery except in so far that the working of the human mind must always remain a mystery. For divining is a psychological phenomenon and one which has not been neglected by psychological investigators. It would appear that it is to be classed as one of the manifestations of what is known as auto-hypnosis, a condition in which the individual so predisposed hypnotizes himself and thereby becomes less conscious of his actions than a person in the normal state, and sometimes, but not always, develops a sharpening of the perceptions which makes him, without the aid of conscious reasoning, observe and interpret facts which at other times would pass his notice. Thus, in some instances, a diviner may quite possibly achieve remarkable success. This, however, does not appear to apply to the generality of *bona fide* dowsers who, as far as one can judge, only deceive themselves and others into believing that they have abnormal powers."[Y12]

In a paper before the Institution of Sanitary Engineers, England, a member of the British Society of Dowsers described sources and types of radiation, referring to radioactive bodies, artificially energized electric cables and solenoids, and certain long static conductors in a less conductive medium; to parallel bands of alternately greater and lesser field strength; plane-polarized radiation; concentric shells plus four cardinal beams, and transverse nodes and antinodes. Flowing water, he explains, boosts the natural, or static, intensity of the field, as measured at its peak. . . . The dowser acts as a kind of combined radio-receiver *cum* ionization counter if his reflexes are not interfered with or inhibited. Following a predetermined procedure in the field, based on knowledge of the typical forms and behavior of patterned electric fields, he can, with the aid of some simple electric accessories, determine yield and depth of, say, a flowing stream below ground as well as its vertical location.[D17]

Transmission of Water Level Data

This article describes a method, called "Telemarking," used by the Miami, Fla., water department for reporting continuously in the office the exact elevation of water in a reservoir 8½ miles away. It consists of a positioning element and a signaling element. The former is a float in a stilling well, from which a beaded cable passes over a float pulley on the Telemark, which positions disks connected by counter gearing and having symmetrically arranged ridges on their upper surfaces; each disk divided into ten sectors, each of which contains a different number of ridges. A contact arm, sweeping across these disks, signals the elevation to the nearest 0.01 ft. The signaling element is a microswitch actuated by the contact arm, powered by a 15-volt dry cell battery. The report comes by regular telephone as a series of dots and dashes.[G28]

Breaks in Cast-Iron Pipe

Records of water departments in 18 cities of 8,000 to 105,000 population in Illinois and Wisconsin, covering periods of 2 to 16 yr., showed that on the average there was one break in cast-iron pipe per year for each 131 miles in service. The age of these pipe averaged well over 50 yr. The causes of breaks were considered to be "faulty construction or interference by other underground construction" in 46% of the breaks, excessive pressure in 8½%, corrosion in 8%, excessive load in 4%, faulty pipe in 4%, and not known in 29½%. Pipe cannot be broken by stresses due to temperature changes within a range of 88° (32° to 120°), nor by vibrations caused by overhead traffic. Failures due to corrosion are rare. Inserting too large taps may weaken the pipe sufficiently to cause it to break; the remedy is to use a fitting rather than a tap. The major cause of breaks in cast-iron pipe is beam action in pipes 8" and smaller, and ring failures in pipes of larger diameters. A pipe acts as a beam only when it is not properly bedded but is resting on blocks, rocks or other structures at its ends or middle. A small pipe cannot break under ring strain caused by backfill of any possible depth, but large pipe may do so, in which case the break will be a longitudinal one. Corrosion can be prevented by using sand backfill adjacent to the pipe in mildly corrosive areas, or special coatings in marshy places, cinders or slag.[A83]

Removing Sand From Well Water

In order to prevent sand in water pumped from wells from entering the water purification or distribution system, several methods have been employed—discharging the water through pressure sand-and-water separators, or traps of both gravity and centrifugal types; through gravity-type concrete sand boxes into reservoirs; and into settling tanks. The author considers that "When consideration is given to both first cost and operating expense, the vertical steel tank, pressure-type centrifugal-action sand and water separator has proven to be the safest and least expensive. It is placed in

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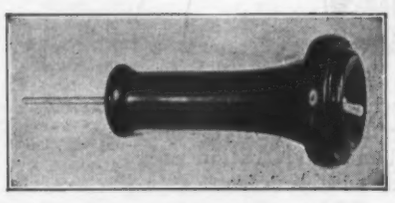

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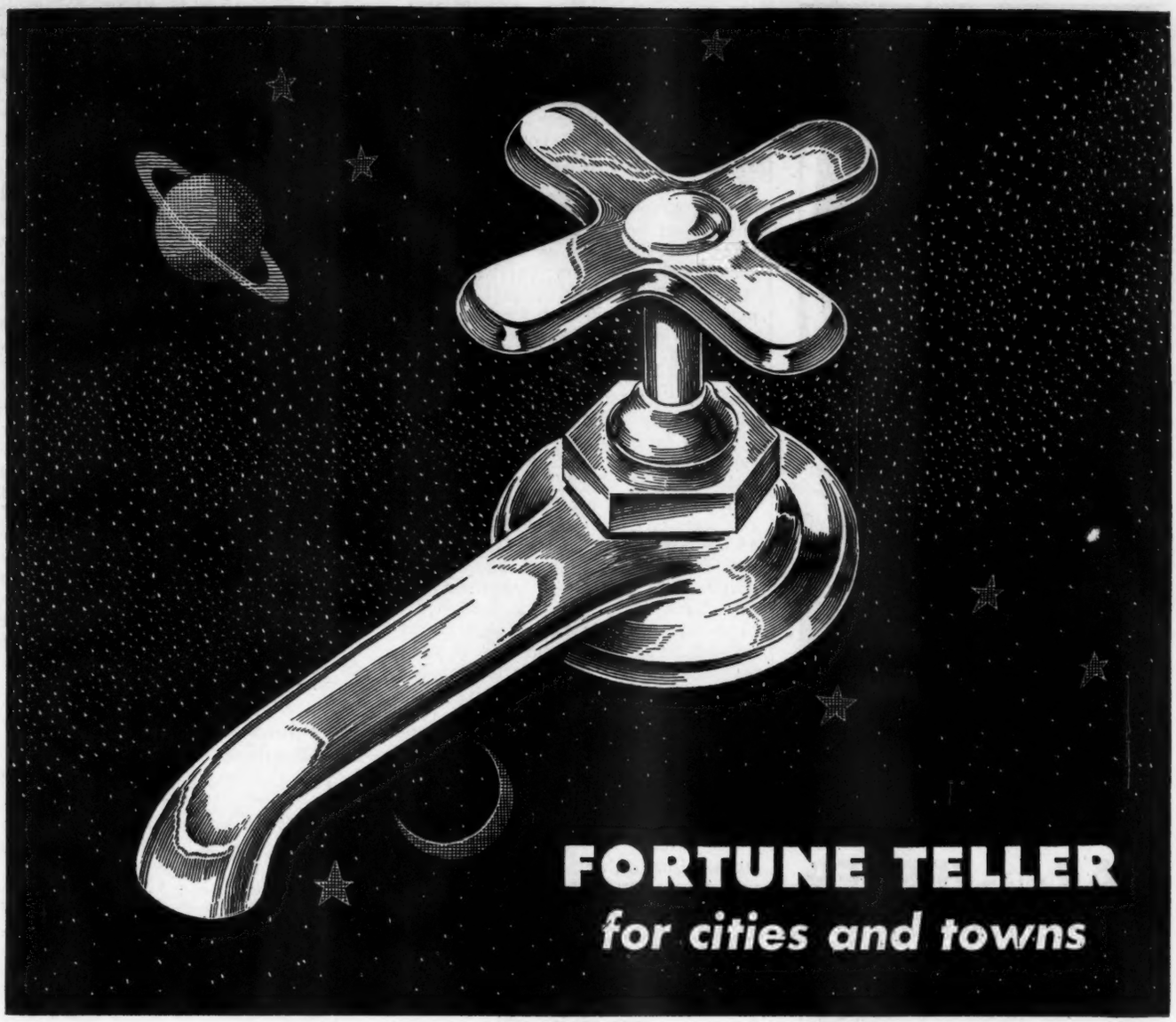

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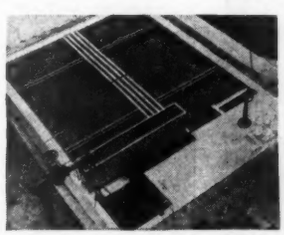

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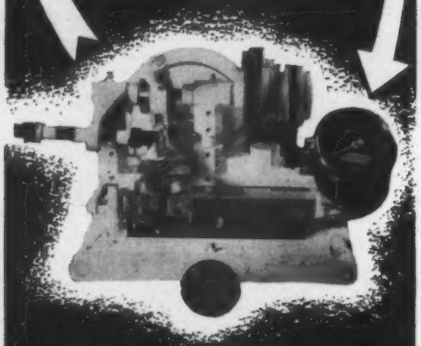

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the well discharge line, where it thoroughly removes from the water sand and silt which is free of colloidal matter.[A84]

Pre-Treatment Settling Time

The Ohio Dept. of Health stipulates a minimum of 4 hr. settling time ahead of filtration, in plants treating surface water. In treating well water supplies not subject to contamination, pre-treatment periods as low as 2 hr. may be considered satisfactory, but where lime treatment is intended to effect bacterial purification as well as softening, 4 hr., during which causticity is maintained, is the minimum that can be considered satisfactory. As a result of studies by Hoover, Streeter, Scott, McClure, Edwards, Bahlman and Van Arnum, it has been concluded that not less than 4 hr. exposure to a pH of about 10.5 or higher is necessary where the lime treatment is depended upon for purification. Some engineers and manufacturers advocate 45 to 90 min. where vertical-flow sludge blanket treatment is used, but the Department is unwilling to accept this because in such cases the purification depends upon chlorination, which should be used not as a prime purification process but only as a safety factor. Sludge blanket type of treatment has its place, but in treating water subject to contamination it should be used only in lieu of mixing and flocculation and should be followed by sufficient plain settling to bring the total pre-treatment time up to at least 4 hr.[A76]

Determination of Iron With o-Phenanthroline

The use of o-Phenanthroline for the colorimetric determination of iron in water is based on the reaction between that substance and ferrous iron to form a highly colored, orange red, complex ferrous o-phenanthroline, which is quantitatively proportional to the amount of iron present in the sample. None of the ions commonly found in natural waters interfere with the color production. The method is ideal for visual comparisons in Nessler tubes. There is considerable color even at concentrations as low as 0.05 ppm of iron.[A77]

Construction Costs And Water Rates

The funds necessary to sustain the essential growth of public water supplies should come from revenues for service rendered. Construction costs in the early part of 1946 were about 40% above those of 1939. Aside from minor recessions, it is believed these costs will continue to increase over the next decade to a general average of 60% to 75% above 1939, and even during the next depression will not recede to within 40% to 50% above costs prevailing in 1939. These costs directly reflect increased wages to labor. Rising costs of operating and maintaining water works will seriously cripple the expansion of water works unless there is an increase in gross revenues of approximately 20%, equivalent to $1.40 per capita per year. Waterworks management must see to it that their rates are so fixed as to provide the funds necessary for needed construction.[A79]

Orifice Flow Meters

The orifice used in a flow meter should be exactly concentric with the pipe. The ratio of pipe diameter to orifice diameter should never be less than 1.25, and at least 1.40 if possible. If distance from orifice to pipe wall exceeds 1" there should be a ⅛" air vent hole as close to the top of the pipe as possible. The upstream tap for the manometer connection should be one pipe diameter from the up-stream face of the orifice plate, and the down-stream tap ½ pipe diameter from the plate; both on the side of the pipe and in the same plane relative to the pipe axis. The taps should be at least ¼", increasing to 1" for 16" pipe. The up-stream orifice should be preceded by straight pipe for at least 20 pipe diameters if the diameter ratio is as low as 1.25, and at least 6 diameters if the ratio is 3 or over; and the pipe down-stream from the lower orifice should be straight for 5 to 3 pipe diameters.[G21]

Filter Sand Specifications

The finest sand that should be used in a rapid sand filter employing 50% expansion is that retained on a 48-mesh sieve. For low turbidity of effluent and to prevent the passage of activated carbon, 35-mesh sand is required. It is preferable to specify "percent retained on" rather than "effective size" or "uniformity coefficient." The 48- and 20-mesh sizes should be limited to not more than 10% each, with the latter omitted if possible. The predominant sizes should be 35- and 28-mesh, in approximately equal amounts. Torpedo sand or fine gravel should be carefully selected as to size.[G24]

Coagulating With Ferric Salts

To effect any coagulation, ferrous sulphate must be converted to a ferric salt, usually by raising the pH with lime and thus producing ferric hydrate and ferric carbonate. If excess lime is added, some will collect in the sand bed; if too little, some of the ferrous sulphate will pass through the filters. Ferrous sulphate can be used by adding chlorine, making ferric sulphate and ferric chloride.

Ferric sulphate is a very good coagulant but was very high-priced before the war, and during the war, industrial uses demanded most of the total production, but it is now becoming available for water purification. Ferric sulphate is not nearly so soluble as alum. It is more soluble in a small than a large volume of water. It is desirable to agitate it violently in water in a dissolving pot for about 30 min., using 3 parts water to one part ferric sulphate, and then

diluted. A 2% solution has been found to be most satisfactory.

Coagulation is rapid, and the coagulant should be added at the point of maximum agitation, followed by 40 min. of flocculation. This coagulant is not sensitive to changes in turbidity or pH. It is very responsive to break-point chlorination. Iron in the raw water will interfere with alum coagulation but aid ferric coagulation.[G25]

Services in Winnipeg, Canada

Winnipeg has about 47,000 services. Wrought iron pipe was used from 1882 to 1894; but the soil conditions were very destructive of w. i. and steel, and the use of lead for small services and cast iron for 3" and larger was adopted in 1894 and continued to 1924, when copper tubing was substituted for 2" and smaller, because the lead pipe became brittle and granular in the local soil.

Services are installed by means of a pipe-pushing machine, of which two types are used, a "Simplex" mechanical and "Greenlee" hydraulic, both satisfactory. Steel pipe is pushed through, then the lead or copper pipe attached to it, and the steel pipe pulled back bringing the service pipe after it. Digging with trenching machines is not favored because of the difficulty of securing adequate compaction of the backfilling.

The city engineer determines the size of the service by allotting a certain number of gallons per minute to each fixture of each type to be served by the pipe in question, and assuming that the pipe must deliver 1/3 of the total of all these amounts for a 1-family house, ¼ for a 2-family house; and that the service be at least ¾" for 1 to 35 gpm, 1" for 30 to 60, 1½" for 48 to 105, and 2" for 90 to 200 gpm.[G26]

Electronic Purification

Electronic purification is obtained by means of passing water through a purifier consisting of a series of aluminum sheets spaced ⅛ in. apart, the water thus being sliced into films ⅛ in. thick. Electric current decomposes the sheets, forming aluminum hydrous oxide floc from the mineral content of the raw water. The floc is formed in 15 to 45 seconds. The method has been tested on Dismal Swamp water, soft with high color; on Florida well water, hard and high colored, and others with various characteristics. These tests indicate that the process will produce a tough floc, and one which will remove more color in all kinds of water than will alum, regardless of temperature, pH, turbidity or hardness; and will remove some temporary and permanent hardness. It is unnecessary to use as much lime to raise the pH after treatment as is required when alum is used; and addition of lime will not increase the color. Tests have not been continued long enough to permit estimates of the life of the aluminum plates or of the cost for electric current.[M18]

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74. Stream Pollution in Southwestern Pennsylvania. By L. S. Morgan. Pp. 713-716.
75. Surface Water Supplies of Wisconsin. By O. J. Muegge. Pp. 717-723.
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81. Coagulation with Ferric Sulfate. By J. B. Nickel. Pp. 755-760.
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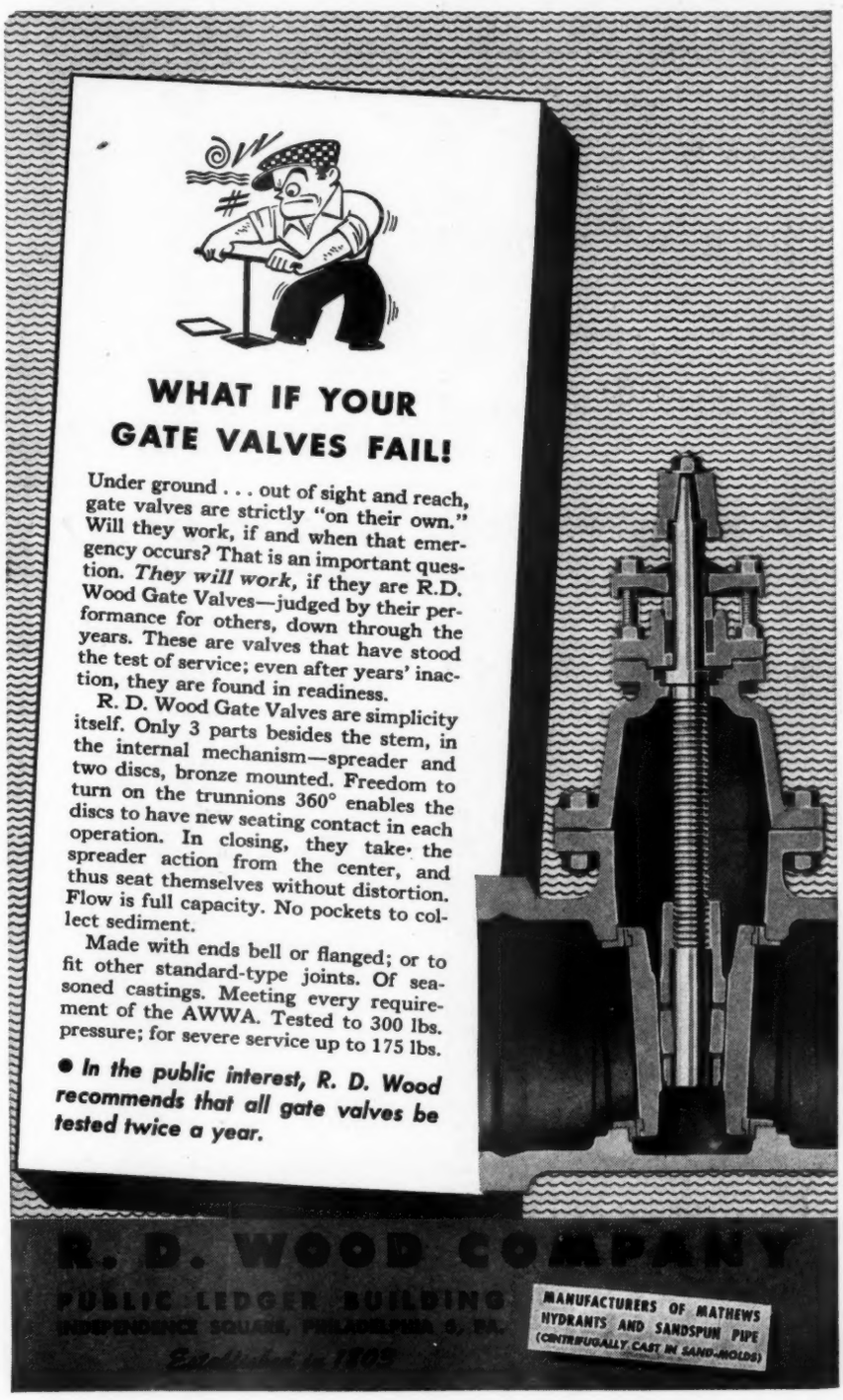
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11. Water Treatment Methods: Fifty Years' Progress. By Godfrey M. Taylor. Pp. 339-340.
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Legal Decisions

Liability for Damage to Roads Under Government Control

Action was brought against the general contractor for the erection of a General School at a Camp in Virginia by companies to whom subcontractors had sublet part of the work, to recover the cost of repairing damage caused by the premature use of roads, a proceeding which the general contractor had encouraged. The general contractor, it was held, could have arranged this work and the work reserved for itself so that the various activities would not interfere with one another, but, inspired by the fear of penalties for delay, it started various parts of the work simultaneously and pressed the subcontractors to complete their respective commitments as rapidly as possible, with the result that the roads had to be reconstructed to conform to specifications and to entitle the general contractor to compensation under its contract with the United States. It was also held that, whether the damage was caused by the general contractor or by persons within its control, the Miller Act gave rise to a contract implied in law imposing upon the general contractor the duty to compensate companies to whom subcontractors on the work sublet the paving of roads for the cost of repairing the roads in accordance with the contract specifications. Ross Engineering Co. v. Pace, Fourth Circuit Court of Appeals, 153 F. 2d 35.

Extra Compensation for Excavation Delays

A proceeding against the United States for compensation for the increased cost of excavation, rolled fill and backfill, which grew out of the construction by the plaintiff of an outlet channel designed to bypass excess water around the Sardis Dam on the Little Tallahatchee River near Sardis, Miss., was brought in the United States Court of Claims. (E. J. Albrecht Co. v. United States, 63 F. Supp. 769.) The plaintiff had no part in the construction of the dam itself, which was being built at the same time.

Excavation and concrete were a ma-

jor part of the work. The contract as to excavation, fill and backfill was on a unit price basis. Plaintiff before bidding had inspected the site, tested the Government's borings and made his own borings. The work was completed on time, and no liquidated damages were involved in the plaintiff's claim. Plaintiff's expenditures for the three items claimed for were $142,120 more than it received as payment therefor. It alleged that delays and increased costs were caused by two items: (1) improper refusal of the Government to permit plaintiff to use dry borrow pit material in rolled fill operations and (2) delay in agreeing to pay the increased cost of imported concrete aggregate, which in turn postponed excavation in the stilling basin from the dry season to the rainy season.

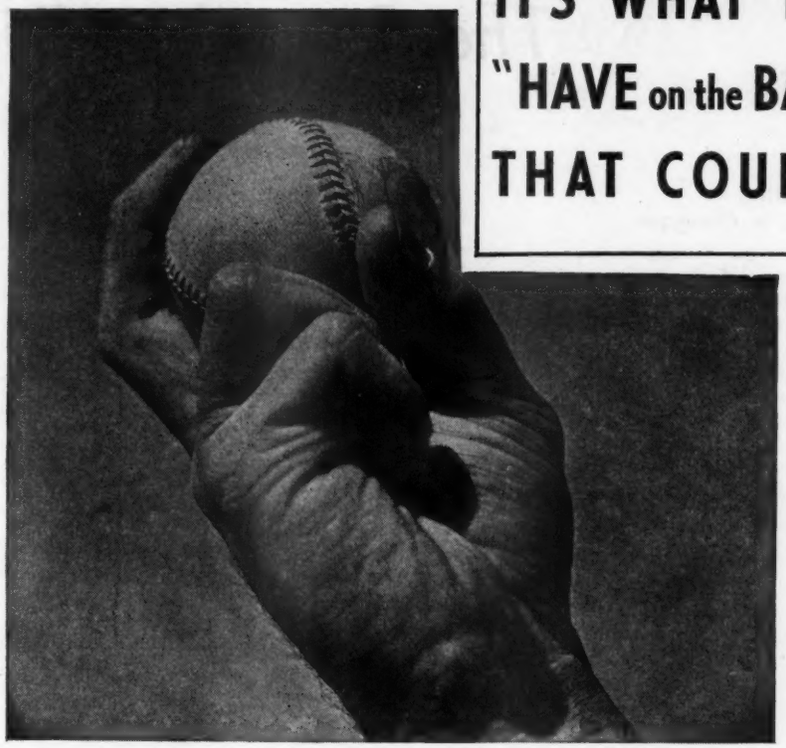
As to the rolled fill controversy, the real issue was that the Government contracting officer, through his representative, the project engineer, did not feel at that time that the Government should incur the added expense of 25 cents per cubic yard for excavation from the borrow pit when it had already paid the same amount for the excavation of material which was suitable for rolled fill with the exception of the moisture content.

The contract indicated that gravel should be subjected to a freezing and thawing test and to analysis to determine its conformity with specification requirements. It was held that there was no proof that the Government's refusal to permit the contractor to use local gravel except below the frost line where the chert in the local gravel could do no damage was arbitrary; and no breach of contract was shown.

The contractor did not make available to the Government samples of the aggregate it desired to use until six weeks after the contractor started work; and two months elapsed between approval of the local gravel and the pouring of the first concrete. It was held that in these circumstances the contractor was at fault and a 3½ months delay was not chargeable against the Government in determining whether the contractor was entitled to additional compensation.

The contractor had agreed to postpone the excavation of the stilling basin and to excavate an approach channel first, and he was held not entitled to extra compensation because of the increased cost of excavating for the stilling basin during the rainy season. The delays which occurred during the gravel controversy between the contractor and the Government being held chargeable to the contractor, he was held not entitled to extra compensation because the controversy delayed the excavation until the rainy season and thereby increased the cost.

The denial by the contracting officer and the chief engineer of the plaintiff's claim was therefore held not arbitrary or unreasonable.



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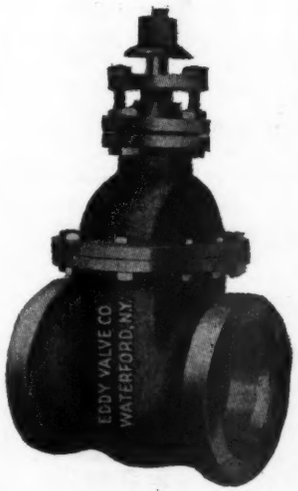

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The Sewerage Digest

Ventilating Sewers in Glasgow

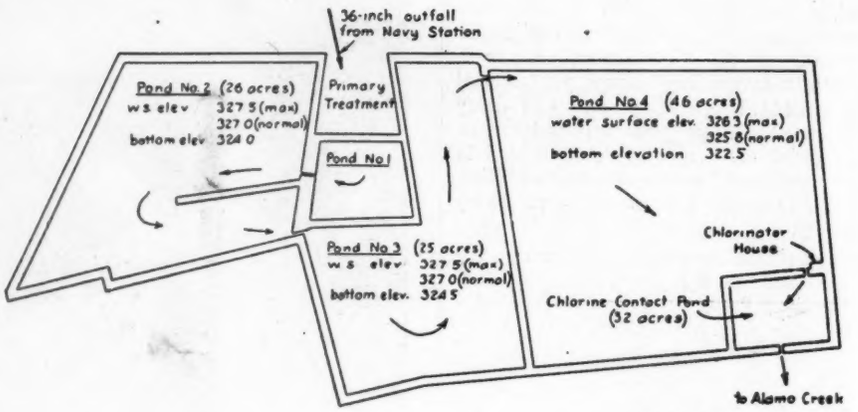
Sewers in Glasgow, Scotland, are from 10 to 35 ft. deep, very large and frequently needing cleaning. In ventilating them (while men were working in them), by opening manhole covers, it was found that depth of sewer had no effect on the air current, neither did direction of wind, but turbulence of the sewage after a heavy rain increased the air current. To assist ventilation, they use a fan driven by a 1¾ h.p. gasoline engine drawing 5,000 cu. ft. of air per minute. The fan has a flange on the suction which fits into the standard manhole frame. The two manholes above and below the section being cleaned are opened, a canvas blanket is fastened in the upstream opening of the upstream manhole and the downstream opening of the other, and the fan placed over the upstream manhole, toward which the men work, thus drawing the gases liberated by the stirred-up deposit away from the men. This has proved very satisfactory.[D15]

Sewage Oxidation Ponds

The first oxidation pond in California was unintentional, caused by the clogging of a prepared seepage area in 1924. At present there are 30 oxidation pond plants in that state. Where climate is suitable and level land is available and cheap, oxidation ponds offer an economical means of obtaining complete treatment of sewage, at a first cost (exclusive of primary treatment) ranging from $0.50 to $3.00 per capita. If designed properly, they can be expected to produce an effluent suitable for discharge without nuisance into a dry watercourse througout the year.

During the destruction of the sewage organic matter by aerobic bacteria, algae grow abundantly, and the quantity of organic matter appearing in the form of algae cells may at times exceed that originally present in the sewage. When these algae are decomposed by bacteria they may exhibit a high B.O.D. but do not cause objectionable odors. Thus the total organic matter in the pond effluent may be appreciable, but little if any of the original sewage organic matter remains. The coliform-type bacteria are destroyed rapidly in the presence of algae. This is believed to be due to the liberation by the algae of substances toxic to bacteria. Chlorination of the effluent was not successful; it partially killed the algae, but the coliform bacteria increased slightly. In the oxidation ponds at the U. S. Naval Station, Shoemaker, Calif., the average D. O. in the effluent (monthly averages) varied from a few tenths of a ppm to 15 ppm; but the D.O. in the disposal stream never fell below 4 ppm although during the greater part of the year there was no flow other than plant effluent. The B.O.D. values in the effluent gave monthly averages of less than 20, frequently 5 to 10 ppm.

Sewage ponds are seldom successful if the percolation plus evaporation exceeds 40,000 gal. per acre per day. Only clarified sewage should be applied. The size of the pond should give a minimum detention time of 25 days and a minimum surface area of 1 acre per 400 contributary population. The depth should never be less than 3 ft. The incoming sewage must be mixed immediately with sufficient partially treated algae-bearing pond water to eliminate odors and septic areas. Earth banks should be kept free of weeds. If this is done and good slope of the banks is maintained, there will be no mosquito breeding.[C28]


36-inch outfall from Navy Station
Pond No 2 (26 acres)
w.s. elev 327 5 (max)
327 0 (normal)
bottom elev 324 0
Primary Treatment
Pond No 1
Pond No 3 (25 acres)
w.s. elev 327 5 (max)
327 0 (normal)
bottom elev. 324 5
Pond No 4 (46 acres)
water surface elev. 326 3 (max)
325 8 (normal)
bottom elevation 322 5
Chlorinator House
Chlorine Contact Pond (32 acres)
to Alamo Creek

Courtesy Sewage Works Journal

Plan of oxidation ponds at Naval Station, Shoemaker, Calif.

Treating Creamery Wastes

A creamery plant at Hillsboro, Kans., has built a treatment plant for disposing of its wastes, which are estimated at 24,000 gpd, contributing about 200 lb. of BOD, in addition to unpolluted condenser water and domestic sewage. The last goes to an Imhoff tank. The polluted wastes, including the Imhoff tank effluent, are pumped to filter No. 1, 21 ft. in diameter and 6 ft. depth of rock, with disc type distributor. The effluent from this goes to a settling tank with a 2 hr. detention; then to filter No. 2, 17 ft. diam. by 4 ft. deep; then to a final settling tank. The effluent from this, together with the unpolluted water, goes to a pond of 6500 cu. ft. capacity, sufficient for about 40 hr. retention; the effluent from which is to be used for irrigation. Recirculation is provided by returning 80% of the effluent of each of the settling tanks to the preceding wet well, the other 20% passing on to the next stage. The recirculation is effected by automatic pump control to return approximately 80 gpm. Sludge is digested in a small covered digester, and a 416 sq. ft. drying bed is provided.[H32]

Handling Industrial Wastes

The Committee on Industrial Wastes of the California Sewage Works Ass'n has reported at length on "the policy and problems involved in the disposal of liquid industrial wastes." Their report analyzes the methods used in handling industrial wastes; the factors to be evaluated in arriving at a charge, or basis of a charge, for handling them, and outlines a suggested public policy. As to the last, "The committee is of the opinion that the community as a whole should finance the construction of a sewer system as well as the treatment and disposal works, otherwise it may be confronted with the perplexing situation of having to reserve to the industries their capacity rights, regardless of the community's increase in population or other circumstances which may increase the sewage flow and dictate the construction of new works or extension of the old.

"Whatever means are chosen, it would seem that the construction of public works required to dispose of sanitary sewage and such industrial wastes as may be admitted to the sewer is the obligation of the community as a whole, no matter

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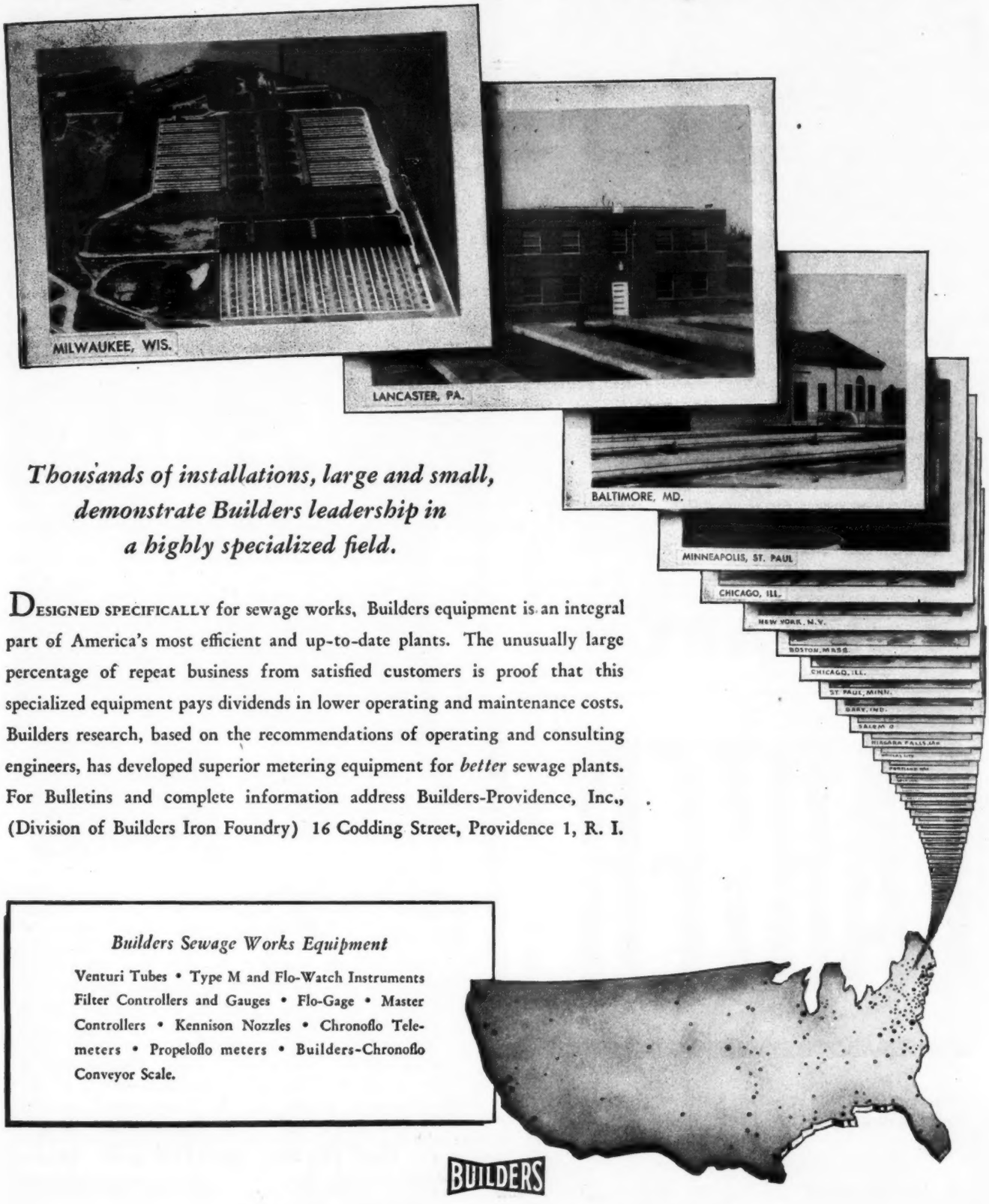

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what means of financing construction or operation are employed, and that the community as a whole should own the public sewage works and have the authority to regulate the quantity and characteristics of flow thereof in any manner most consistent with all of the circumstances involved.

"From this it would follow that the construction cost of the works should be spread on an *ad valorem* basis over the area designed to use the system unless, of course, all or part of the bonds sold for construction purposes are self-liquidating and to be repaid or retired from legally imposed service or rental charges. The committee is more inclined than not to believe that construction and operation charges should be distinct and separate and that no industry should be called upon to construct a definite portion of a sewage treatment works unless it is assured that the proportion of the capacity which it is purchasing is reserved for its use as long as the plant continues in operation.[C34]

Clogging of Air Diffusers

At Elyria, O., iron pickling wastes enter the sewers in considerable quantities, and although they are neutralized by the normal alkalinity of the sewage by the time they reach the plant, the pH of the raw sewage is frequently less than 7.0, and iron is precipitated in the aeration tanks and on the diffuser plates in them and in the influent channels to them. As much as 6" or 7" was deposited in the aeration tanks in a single week. In May 1945 the plates were cleaned but quickly clogged again, and again were cleaned several times by spalling their surfaces, but clogged quickly. Then five 7/64 in. holes were drilled in each diffuser plate in the influent channel. This did not decrease the purification efficiency, and eased the pressure on the air compressors.[C34]

The Southerly plant at Cleveland, O., has two aeration tanks, No. 1 equipped with 1500 aloxite plates of No. 40 permeability, No. 2 with 1500 porous carbon teardrop diffuser tubes of No. 20 grade, of the lift type. After three months' operation the tubes in tank No. 2 became seriously clogged and were lifted out and washed with water, but in a few days this had to be repeated. The clogging apparently was due to iron, the sewage content of which averaged 100 ppm and at times reached 400 ppm. The 1500 tubes were removed and cleaned with acid and only 700 of them replaced, with the idea that greater air velocity through the limited number might prevent deposits, this velocity being increased from 2.5 cfm to 5.0 cfm per tube. But in a short time the tubes started to clog again. Shortly thereafter the content of iron pickling wastes decreased and the tubes have been kept in operation by cleaning twice a year. Meantime the aluminum plate holders in tank No. 1 had deteriorated so badly by corrosion that the plates were removed and replaced with perforated pipes, which do not clog, and tests show 1.5 to 2.5 ppm of dissolved oxygen in the mixed liquor.[C36]

In 1943 Ann Arbor, Mich., removed the porous plates from the aerated channels leading to the aeration tanks because of the disintegration of the aluminum plate holders, and replaced them with simple galvanized pipe manifolds using a celluloid capillary tube for the diffuser. "They seem to be working out very satisfactorily." [C38]

Efficiencies of Primary Plants

To say that a plant has been operating either "well" or "poorly" because the reduction of suspended solids was 66% or 46% or 86% is absolutely meaningless unless the sampling procedure, theoretical detention period, suspended solids in the raw sewage, and percentage of infiltration also are considered. In almost any plant, by selecting sampling hours, a 90% reduction on any given day may be indicated, or, on the other hand, a 100% increase. Before any true comparison of plant efficiencies can be made, a uniform system of sampling is absolutely mandatory. It is suggested that five influent samples be composited at

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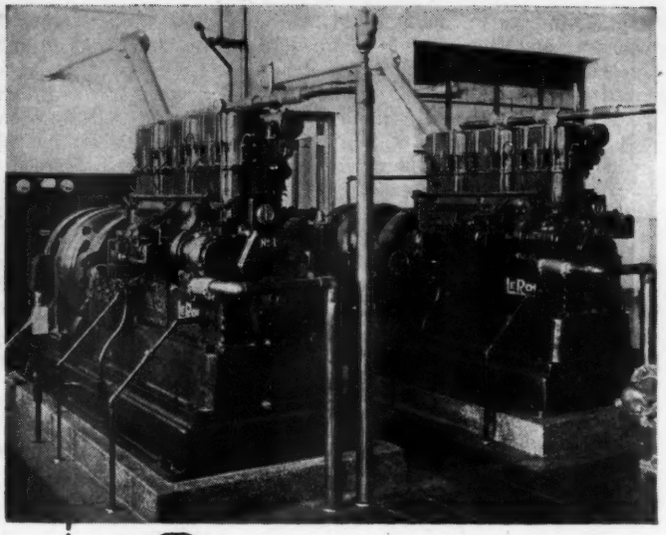

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30 min. intervals from 9 to 11 A.M., inclusive, and five effluent samples be taken at corresponding times, as determined by the rate of flow, to allow for the settling period; all samples being proportioned to the rate of flow.

The efficiency of the plant in relieving the receiving water-course of organic pollution (which is the reason for the existence of sewage treatment plants) should be expressed as the total pounds of organic matter or O.D. removed from the influent. The true measure of *operating* efficiency for primary plants is the percentage or amount of *settleable* solids removed, which is quite different from removal of total suspended solids. In rating plant efficiencies and in establishing standards of performance, it seems reasonable to require that primary treatment plant effluents should not exceed a fixed amount representing ppm non-settleable solids content of the sewage in question, plus a given percentage of the suspended solids in the influent. The ppm suspended solids in the sewage reaching a given plant varies with the percentage of storm water and infiltration.[C27]

Reducing Short-Circuiting

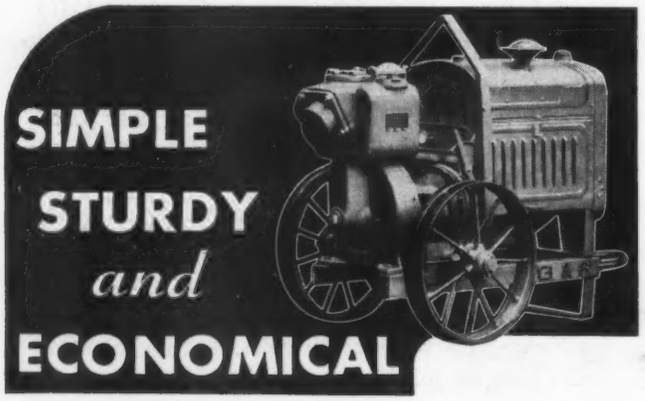
"The only way an engineer can better the effluent of a primary treatment plant is to design sedimentation basins so as to reduce short-circuiting." Measures which the authors found effective in securing this were as follows: 1. Influent flumes were tapered proportionally to the flow so as to maintain a velocity of 1.0 ft. per. sec. at all inlet ports. 2. A flocculator was provided for agglomeration as well as to smooth out the daily differentials in temperature and suspended solids. 3. The sedimentation basin was roofed over with a concrete slab on which was placed a 4 ft. earth cover to prevent thermal overturns. 4. Effluent weirs were made easily adjustable and of sufficient length to prevent high heads during peak flows. 5. The tank was designed as shallow, narrow and long as space, subgrade and economic limits of design would permit.[C27]
[C27]

Trends in Sewage Works

Due to recent research, manufacturers will furnish simpler and more efficient machinery, durably built to withstand hard service. Marked improvement may be expected in metering and control equipment. Recent development of dual fuel engines will stimulate the use of digester gas engine installations, and in smaller plants than formerly were believed economically adapted to gas utilization for power. Progress being made in heat drying of sludge should bring about greater use of sludge for soil conditioning; which should be aided by the early publication of the manual "Utilization of Sewage Sludge for Fertilizer" by the Federation of Sewage Works Associations. Some corrosion-resistant metals and alloys, such as aluminum and stainless steel, have been made cheaper by war production and should find much wider application in sewage works; as also should new plastics and protective coatings developed for wartime purposes.[G13]

Film in Percolating Filters

Investigation of the growth and distribution of film in percolating filters at the Birmingham, England, Minworth plant (see *Sewerage Digest* for February, 1946) led to the following conclusions: The rates of growth of a zoological bacterium and the fungus *Ascoidea* at 10° C were about half the rates at 19°; 10° to 15° was the most favorable temperature for the fungus *Sepedonium*. Decomposition of film during the summer was performed largely by larvae of the *Phychoda alternata*. The decrease in rate of growth of film during the winter is more than compensated for by the decrease in number of the insect scourers. Enchytraeid worms inhabit the upper layers of the filters in appreciable numbers during the winter but have less effect than the larvae in maintaining a favorable balance between growth and disintegration of film. In the spring recovery from winter conditions, the concentration of film at the surface of the single filter was about 50% greater than at the surface of the alternating



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double filters. The more even vertical distribution of film in the latter permitted them to carry larger total amounts without obstruction to flow. On the basis of total dry weight of film, the top two feet contained 62% of the total film in the single filter and 44% in the double filters.[D28]

Plain Aeration Of Sewage

The Ley Creek activated sludge plant of Syracuse, N. Y., dries the sludge on 30,000 sq. ft. of open beds and 15,000 sq. ft. of covered ones. During the unusually wet summer of 1944 it was found possible to dry the sludge as rapidly as it was produced, and during the winter of 1944-45 one-half of the settled sewage was treated by plain aeration, i. e., aeration without return of the sludge. During two weeks of this period the flow was more than twice the design capacity of the plant. During the plain aeration study, one-half of the flow was treated in two of the four aeration tanks.

During the 6-month study, while the BOD of the sewage varied from 23 ppm to 124 ppm, that of the aerated and settled effluent was consistently in the low 20's, dropping below 20 on only 3 occasions when the BOD of the sewage was very low. The trend of the BOD of the activated sludge effluent is considerably lower than that from plain aeration, but there is considerably more variation. Increasing the amount of air applied in plain aeration did not noticeably increase the reduction of suspended solids and BOD. For the most part the effluent was turbid and did not approach the sparkling appearance typical of activated sludge effluent.

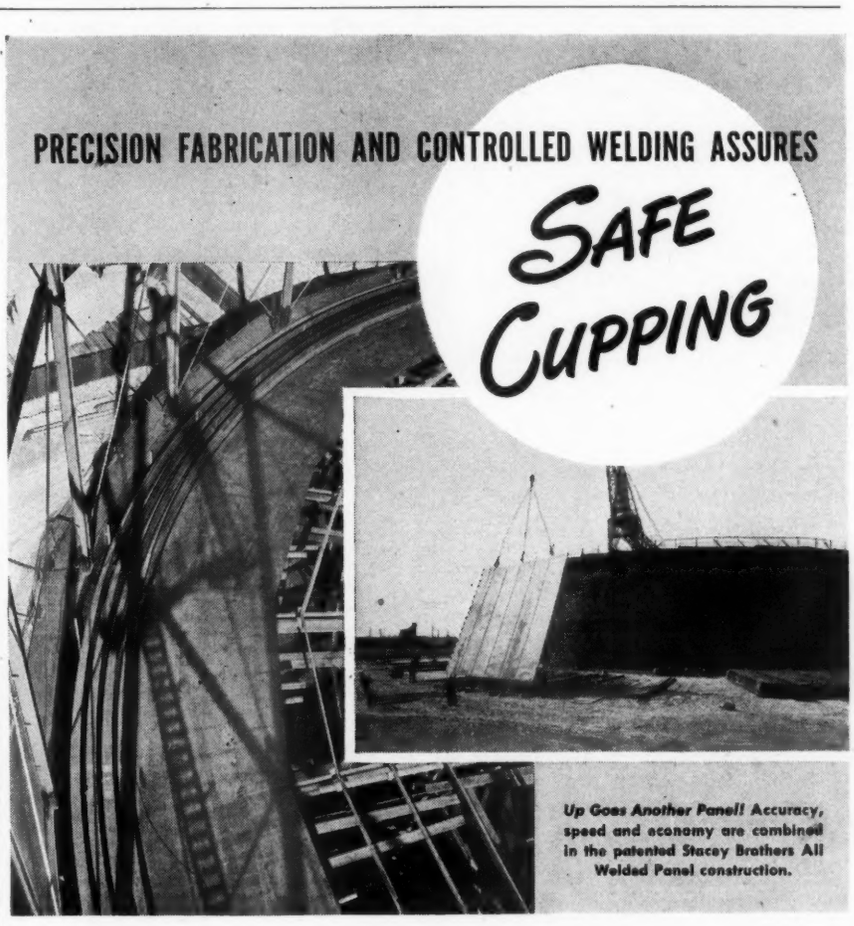
Conclusions reached were that plain aeration and settling will afford a positive degree of treatment between the limits of primary treatment and activated sludge treatment. The most important advantage of plain aeration, as studied here, is reduction in volume (by virtue of increased concentration) of the mixture of primary and secondary sludges. It is suggested for use in cold weather when drying beds are not usable. Also it might be advantageous for pretreatment where secondary treatment units are seriously overloaded or are subjected to abrupt shocks of strong industrial wastes.[C29]

Boston Harbor Disposal Plant

Boston harbor receives an average of over 250,000,000 gal. of raw sewage a day, discharged at Moon Island on the outgoing tide, and at Deer and Nut islands continuously. Although there is great dilution in the harbor, whose waters have contained 57% oxygen saturation, grease and other floating matter characteristic of sewage reach the numerous bathing beaches, and to remove these from the Nut Island outlet the Legislature has made an appropriation for a sewage treatment plant there. This plant will aerate the sewage for 20 min., detain it for 1½ hr. in sedimentation tanks, chlorinate the effluent during the recreational season; digest the sludge and utilize the gas for pumping, and possibly dewater 10% of the sludge for a low-grade fertilizing mulch. The design rate is 112 mgd. There will be racks with 1½" slots, mechanically cleaned from the down stream side; the material removed being dropped onto a sorting table and cans, bottles, rubber balls etc. removed from it by hand and the organic matters returned to the sewage. There will be six grit channels 10½ ft. wide by 80 ft. long, grit washers of the jig type, six 36" comminutors; also four low-lift pumps, a 10 ft. x 5 ft. Venturi meter, aeration channels, sluice gates etc.[L3]

Sludge Drying In Tonawanda

In 1943 Tonawanda, N. Y., added digesters and open sludge beds to its plant, the beds previously in use being covered. Both types of beds were made with completely graded sand and an underdrainage system that included a drainage channel in the center of each bed to which the bottom of the bed slopes on each side. Comparison was made of the drying time required by the open and the glass-covered beds during the season of May to October. Sludge was



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drawn from the same digester to beds of both types, to a measured depth of 10". The average drying time in the open beds was 6 days as compared to 12 days for the enclosed beds. During the hottest weather the drying time on the enclosed beds dropped to a minimum of 10 days but during early spring and late fall it was as high as 20 days. The open beds are used to maximum capacity during the summer, and the covered beds to maximum capacity in winter; but with sustained weather below freezing, not much dried sludge fit to handle is produced.

For removing sludge from the open beds, concrete tracks to support a truck were constructed on top of each sand bed. A motor-operated belt loader is used for loading dried sludge from bed to truck and is preferred by the operators to the bucket and overhead runway provided in the glass-covered units.[C32]

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30. Effect of Food Wastes on Sewers and Sewage Treatment. By Morris M. Cohn. Pp. 477-483.
31. Grit Collection and Conditioning. By R. C. Merz. Pp. 484-492.
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33. Treatment of Cyanide and Acid Plating Wastes. By Nicholas Herda. Pp. 499-526.
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11. Locating Lost Sewers and Manholes. By E. T. Cranch. Pp. 149-150.
12. Equipment and Tools for Sewage Works. By Seth G. Hess. Pp. 150-151.

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13. Present Trends in the Sewage Works Field. By W. H. Wisely. Pp. 191-194.
14. High Capacity Trickling Filters. By J. A. Montgomery. Pp. 198-203.

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31. Port Huron to Digest Garbage. By W. R. Drury. Pp. 306-308, 328.
32. High Rate Filters Treat Creamery Wastes. By Murray A. Wilson. Pp. 309-311.
33. Treatment Trends in England. By L. B. Escritt. Pp. 314, 328.
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30. Practices in Regard to Sewer Rentals in 190 Cities. P. 32.

Hypochlorite for Sewage Treatment

A concise envelope mailing type folder giving detailed information on the use of Pittchlor (70% Calcium Hypochlorite) for use in and in connection with sewage treatment plants. Write Pittsburgh Plate Glass Company, Columbia Chemical Division, Fifth Ave. at Bellefield, Pittsburgh 13, Pa., for Form A-704.

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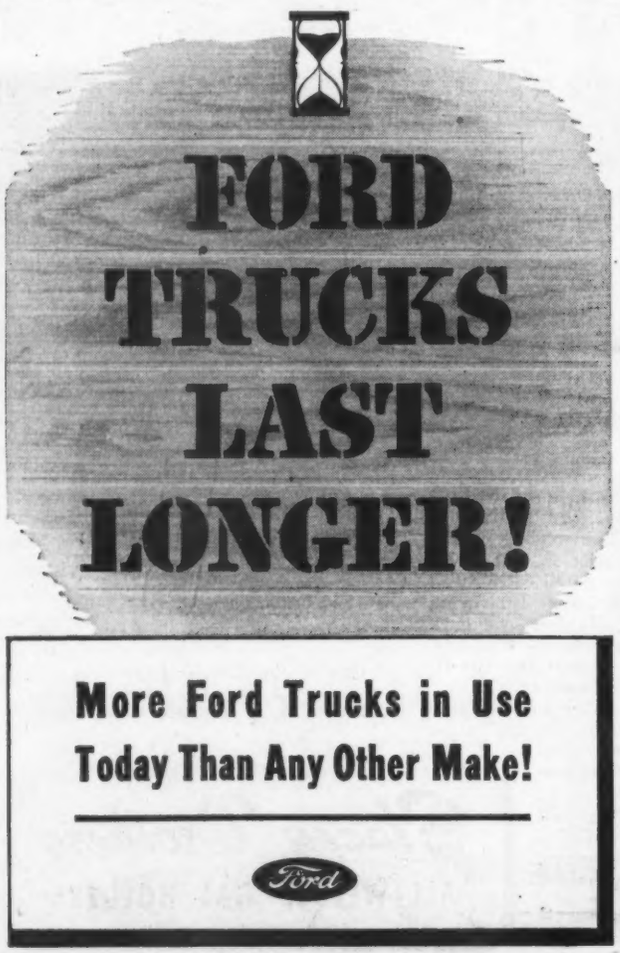

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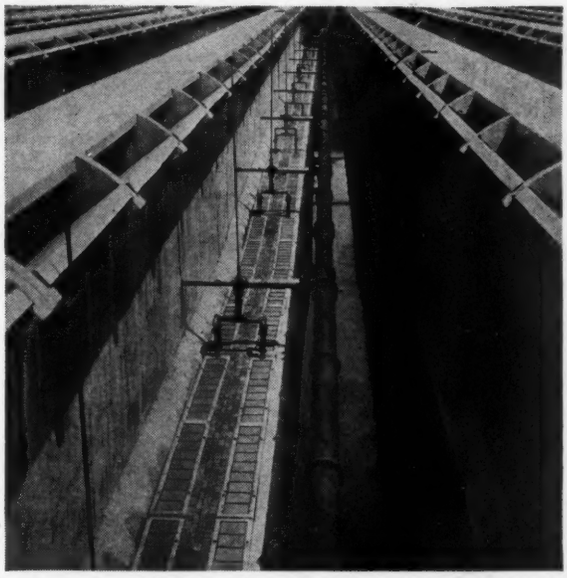

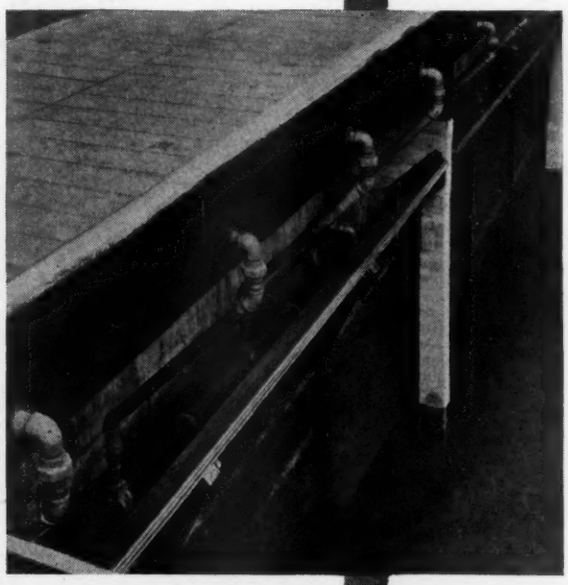

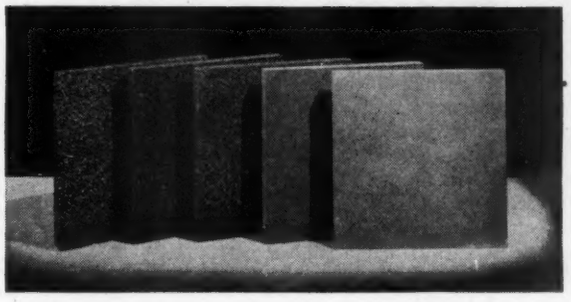

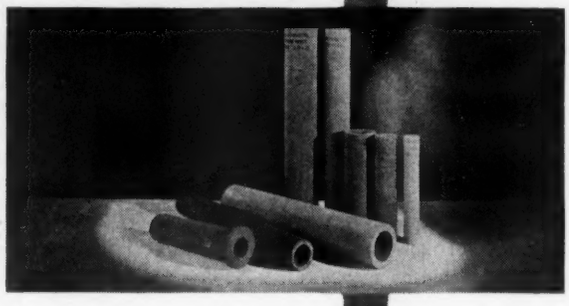

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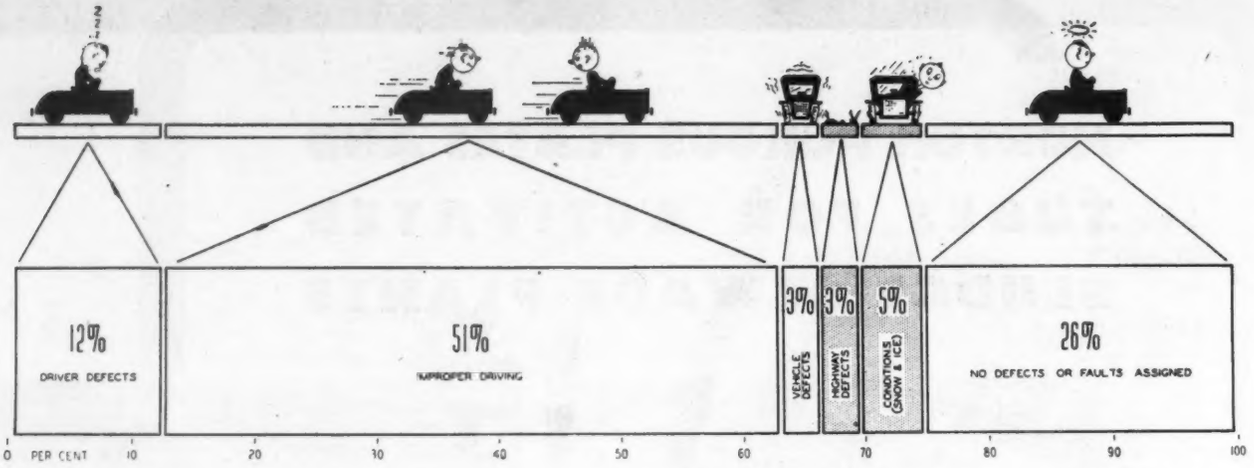


Courtesy Roads and Bridges

Factors in the occurrence of road accidents, causing deaths or personal injuries, based on 1941 Michigan data.

The Highway and Airport Digest

Accident Hazards

The Michigan State Highway Department estimates that, beginning in 1946, there will be a net annual increase of more than 100,000 car registrations in that state until prewar density of ownership is reached about 1951, after which it will continue at a declining rate. Also that traffic will return to its prewar trend at about the same rate. Past experience seems to show that the number of accidents varies with traffic volume, and also with some economic and psychological factors; (boom psychology is not conducive to caution in driving).

The responsibility of the highway itself for accidents is small. According to data compiled by the Michigan State Police in 1941, the causes of accidents were reported as follows:

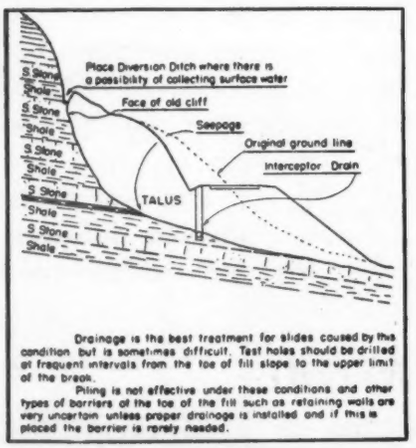
Improper driving	51%
Driver defects	12%
Total for driver	63%
Vehicle defects*	3%
Road defects	3%
Snow or ice on road	5%
Total for road	8%
Other or no defects	26%

*By last year this percentage had nearly doubled.

The highway department found that there were 11 fatal accidents per 100 million vehicle-miles on trunk lines and over 19 on county roads. Also that the rate was 13.4 on gravel roads and 12.5 on paved roads. Accidents on the Willow Run expressways were 56.9, on U. S. divided highway No. 112 were 104.9, and on the rural trunk line system 88.3. The cause of the high rate on No. 112 is because it has become the main street of a long ribbon development; the low rate on the expressway is due to limited access and grade separation.[032]

Slide Control

Almost without exception, slides are caused by the presence of water. As soon as there is evidence of movement of ground above or below a road, the first thing to look for is water. It may be from wet-weather springs on the hillside, but more often comes from water bearing strata. If the water is from springs or surface drainage, it usually can be diverted and removed by diversion ditches. If it is from water-bearing strata, holes can be drilled (as by augers) or trenches dug to locate them; and it then is possible to place drains above the roadway to intercept the water. If the fill over a pipe culvert begins to move, look for a leak in the culvert. A dry slide may occur when the toe of a rock or shale slope is disturbed, and the toe of such a slope should not be disturbed. The road grade and ditch should not cut into a sloping stratum of rock or shale and leave it unsupported. The surface of slides should be kept as smooth as possible to permit the surface water to drain off rapidly instead of soaking in.[N44]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Seepage
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Interceptor Drain
TALUS
S Stone
Shale
Drainage is the best treatment for slides caused by this condition but is sometimes difficult. Test holes should be drilled at frequent intervals from the toe of fill slope to the upper limit of the break.
Piling is not effective under these conditions and other types of barriers at the toe of the fill such as retaining walls are very uncertain unless proper drainage is installed and if this is placed the barrier is rarely needed.

Courtesy Roads and Streets

Method of Slide Control

Longitudinal Cracks in Concrete Pavements

Serious longitudinal cracking has occurred in a number of concrete pavements laid during 1942-3, especially those in Kentucky, Indiana and Illinois, and the matter was investigated in 1943 and 1944 by the state highway departments of those states and the Public Roads Administration. None of these pavements was reinforced. All had a dummy center longitudinal joint, the width of the ribbon in the joint being 25%, 30% and 33%, respectively, of the depth of pavement in the three states. Illinois and Kentucky had previously used a deformed metal plate in such joints but omitted them because of war scarcity. Also all omitted load transfer devices at transverse joints. The subgrade and drainage conditions were generally good.

In the 1943 survey, all but one or two of the longitudinal cracks were found in panels where the dummy center joint had not fractured and therefore was not functioning as a longitudinal joint. The cracks were from 0 to 36" from the joint, 60% of them 12" to 24", and some crossed from one side of the joint to the other. Older pavements were examined, and a few longitudinal cracks found, always where the center joint had not separated.

"This survey leads to the conclusion that the important cause of the longitudinal cracking . . . is the failure of the

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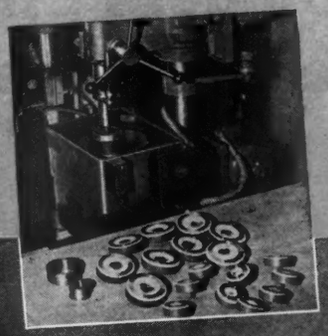

"Ultra-lapping" produces precision finished valve surfaces never before obtained.

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When you need special information—consult the classified READER'S SERVICE DEPT., *pages 71-73*

dummy longitudinal joint to crack through promptly as intended. . . . Consideration of the various conditions that tend to produce transverse tensile stress indicates that in a pavement that does not have complete partition of the concrete along the center line, the most important cause of transverse tensile stress in the region of the center line is restrained temperature warping." The fact that heavy war traffic did not cause cracks where there was a definite separation at the longitudinal joint indicates that such traffic would not have caused longitudinal cracking if the center joint had cracked as intended.

"The most logical remedy for longitudinal cracking of the type studied is the use of a longitudinal joint that will have definite separation at the time of construction." [U4]

Concrete Pavement 35 Years Old

In 1911 Sioux City, Iowa, laid about 4 miles of concrete pavement on streets 24 ft. to 52 ft. wide, on some of which the traffic was light residential, on others 4,000 vehicles per 12 hr. period. In the 35 yr. since, about the only maintenance required has been to clean out the joints and cracks and fill them with asphalt occasionally. Few cracks have developed and the original float and tool marks are still visible on much of it. These pavements were laid in one 5" course, although previous to that all concrete pavements had been laid 2-or3-course. The mix was 1:3:4½, the coarse aggregate being quartzite crushed to a maximum size of 1½ in. It was tamped by hand until mortar formed on the surface and finished with long-handled wooden floats. Expansion joints 7/8 in. wide were placed 30 ft. apart and filled with hot asphalt, and construction joints 12 ft. apart in both directions.[E20]

Acquiring an Airport Site

Davenport, Ia., in 1944 purchased 620 acres of farm land for an airport site for $165,000. It is within 15 min. driving time of the business section, well drained, reasonably level. The land was leased back to the owners for farming until construction shall begin, yielding an annual income averaging $8,500. It is estimated that even after construction of the first stage of the airport, about 250 acres with two of the four existing farmsteads can still be leased for farming for about $2,500 a year. The initial construction planned is for a Class III field, to be expanded later to a class IV field.[J15]

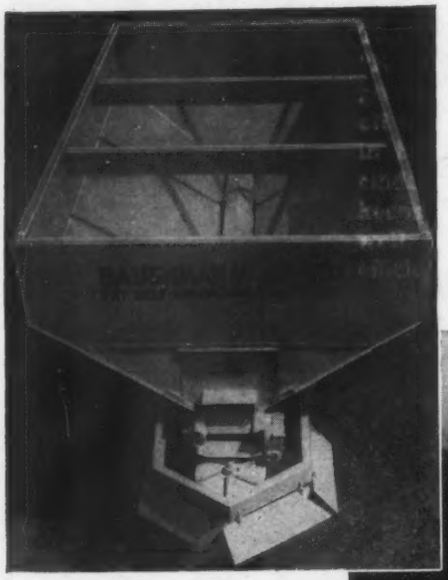
Resurfacing With Asphaltic Concrete

Fort Wayne, Ind., for 15 years has used hot-mix bituminous concrete made with fine-graded aggregate for resurfacing and patching old sheet asphalt and bituminous concrete pavements and concrete sidewalks. For aggregate they use approximately equal parts of limestone screenings and sand, both obtained locally. For street patching and resurfacing, the mix is 8 to 9% asphalt cement, 40% screenings and 60% sand. In 1945 a resurfacing course of this, 1" thick, was placed on a 2" binder course. It closely resembles sheet asphalt. In resurfacing a disintegrating coarse-graded asphalt concrete, where the surface was comparatively dry a tack coat of about 0.1 gal. of MC5 per sq. yd. was applied and permitted to cure about 3 days before the resurfacing. In resurfacing old concrete sidewalks, the asphalt content is increased to 11%, and 1 lb. of No. 3 fuel oil to ¢7 lb. of asphalt cement is added to give adhesion; the asphalt being laid with a thickness of from ¾" to a feather edge.[J12]

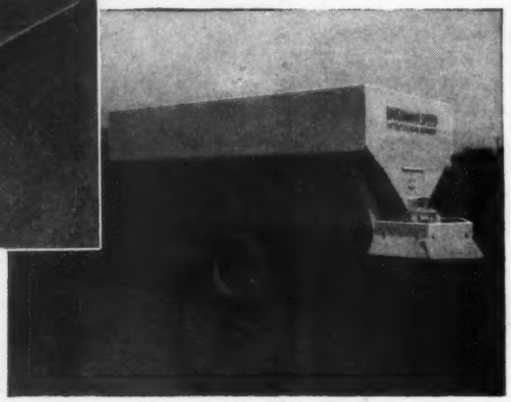
Widening a Concrete Pavement

Texas is widening hundreds of miles of old 18 ft. concrete pavements with 4 to 6 ft. of new concrete slab, generally half of the widening on each side. In a recent 25 mi. project, 3 ft. was placed on each side of a 9-6-9 pavement. The new strip at contact with the old pavement was 14" thick, the additional 5" extending under the old concrete for 4" back, and sloped to 6" at the outer edge. The widening strip was reinforced with 3 longitudinal bars and transverse U bars extending under the old slab at 4 ft. intervals.[84]

Spreads Cinders Efficiently in Sub-Zero Temperatures



The BAUGHMAN Special "K" Model Cinder Spreader gives top performance under *all* weather conditions. Built-in heater prevents water in cinders from freezing . . . keeps mechanism warm as well. Result: a free-flowing, efficiently-spread load.



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Special baffle plates keep spread within desired area. Spreads from 8 ft. to 30 ft. . . . speeds from 5 to 25 m.p.h. . . . completely regulated volume. Available in capacities 9, 11, 13, 15, and 17 cubic yards.

Ruggedly built of high-tensile alloy steel . . . 30% lighter, 17% stronger . . . abrasive and rust resistant . . . all welded construction. Genuine Timken bearings . . . heavy hardened cut-steel gears. *Write for complete information.*

(LEFT) Baughman Model C spreader for dump bodies. Requires no hopper. Wide spread pattern. Positive-action. Economically priced.

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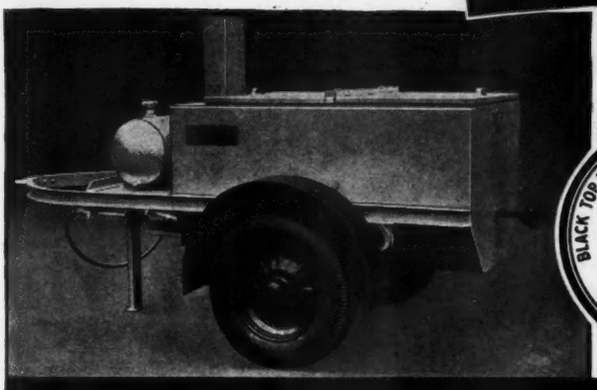
MAKE REPAIRS PERMANENT WITH AN 84-HD ASPHALT KETTLE



Highway, Roads and Streets maintenance work is easy with an 84-HD Kettle. It heats faster and gives a continuous flow of materials because it's designed that way. Two patented features Screened Reservoir and Double Heat Circulation System are found only in this Littleford Kettle. Make repair jobs easier by having an 84-HD to do the job.

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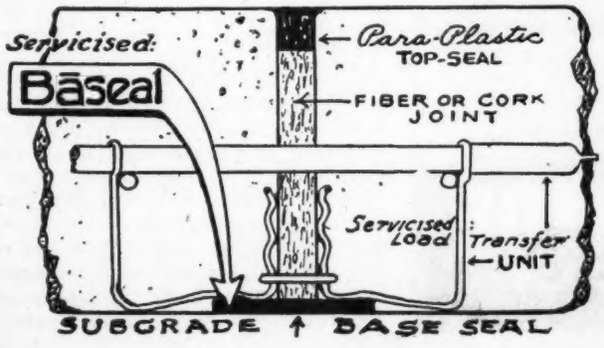

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When you need special information—consult the classified READER'S SERVICE DEPT., *pages 71-73*

The Longest Continuous Welded Bridge

The bridge across the River des Mille-Iles north of Montreal is believed to be the longest continuous welded bridge in the world, being 1550 ft. long. It comprises fourteen spans 90 to 126 ft. long. Girders, each varying from 9 ft. deep at the piers to 4 ft. 7 in. deep at their centers are spaced 32 ft. apart and carry transverse floor beams at 9 ft. centers, which support a concrete deck 52 ft. 8 in. wide. The girders are fixed at the central pier and are carried on expansion rollers at all others; provision being made at each abutment for a movement of 9.7 in. Field welding was kept three spans behind the erection traveler. Some advantages of continuous welding are freedom from intermediate expansion joints in the roadway and marked economy in construction; elimination of necessity for duplicate pier members, floor beams and sway bracing at each pier, and lateral stiffness contributed by the continuous concrete deck.[O30]

Building Road Embankments Across Swamps

A road embankment can be built across a swamp or bog by putting it on a solid bottom, or by floating it and letting it settle to such bottom. Satisfactory results by the latter are uncertain. Methods employed satisfactorily for new construction include: a—For 12 ft. depth or less, complete excavation of soft material and replacing with granular material. b—For deeper than 12 ft., excavate the fibrous, ligneous and a part of the pulpy peat and replace with a porous backfill with a surcharge, if necessary, to displace the peat in the bottom. c—The use of dynamite may be excellent but is not so reliable as *a* and *b*. For reconstruction, if borings show that some fluid peat is confined under the old embankment, the use of dynamite is a good way to get rid of it. If the peat is consolidated and cannot be displaced by dynamite or surcharge, the complete excavation of the old embankment and the underlying peat is probably necessary. The best solution may be to go around the swamp.[O36]

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Consolidation

New Standard Limits for Trucks

The members of the American Ass'n of State Highway Officials have adopted standards for maximum dimensions, weights and speeds of motor vehicles. These specify that no vehicle, unladen or with load, shall exceed 96" in width, 12 ft. 6 in. in height, or 35 ft. in length (including front and rear bumpers) for trucks, 40 ft. for buses, 50 ft. for truck-tractor or semi-trailer, or 60 ft. for any combination of vehicles. As to speed, trucks are limited to 45 mph, passenger vehicles to speeds "consistent with safety," vehicles with solid rubber or cushioned tires to 10 mph; but no vehicle shall be unnecessarily driven at such slow speed as to impede or block normal and reasonable movement of traffic. No axle shall carry a load in excess of 18,000 lb., and maximum loads permitted on a group of axles shall not exceed 32,000 lb. if the distance between extremes of any group of axles is 4 to 7 ft., of 73,280 lb. if such distance is 57 ft., with corresponding loads for intermediate distances.[N40]

Equipment in Airport Construction

In grading the Wilkes-Barre-Scranton airport, 4,000,000 cu. yd. (60% rock) had to be moved. In doing this, the contractor used 16 power shovels, 24 bulldozers, 2 rollers, 41 wagon drills, 25 bottom dumps (15 cu. yd.), a boom tractor, a self-loading scraper, 8 other scrapers, 17 compressors, a rooter, 13 trucks, 5 graders, and 43 trucks (11 cu. yd.).[N41]

Field Test of Bituminous Mixes

The laboratory of the Wyoming State Highway Dept. has developed a rapid method of determining the percentage of bitumen in bituminous mixtures, primarily for field control of oil-aggregate proportions in designed mixes where traveling plant or road mix operations are used. It automatically takes care of the moisture content and absorption of the aggregate. With average aggregates,

the time required does not exceed 15 min. The equipment used includes a thermometer having a range from zero to 220° F; a 1,000 g. capacity balance sensitive to 0.5 g; a special flask of the Chapman type; and a hand scoop; and kerosene or other solvent of low volatility having a specific gravity within the range of 35 to 50 degrees API at 60° F. E19

Embankment Compacting in Iowa

Heretofore the Iowa highway department has specified that embankments be compacted with smooth rollers, but this year it requires use of a tamping type roller of one or more sections not more than 4 ft. long, with feet or studs projecting not less than 6½ in. and of such number and area as to exert a pressure of at least 200 lb. per sq. in. Embankment is rolled in layers of 6" loose thickness, with at least 6 passes of the roller. If too wet to compact sufficiently in 12 passes it is dried by discs or harrows; and if too dry, water is added; such drying and wetting being paid for as extra work.N39

Cost of Maintenance

The cost per lineal foot of filling joints and cracks in concrete pavements ranges from ¼ to ⅝ cents, increasing noticeably after 10 yr. of age. Machine methods cut the cost, possibly 50%. Patching concrete pavements with bituminous materials cost 25 cents to $1 per sq. yd.; with concrete, $5 to $6.70 per sq. yd. Drilling holes in concrete pavement for mud-jacking costs from 7 to 23 cts per hole; pumping in slurry about $10 a cu. yd., and asphaltic mixtures probably 12 cts a gallon. Cleaning and shaping of drainage ditches is more economical by machine than by hand methods. Figures for a period of years show that, of total maintenance cost, 45% is for direct labor, 21% for materials, 25% for equipment and 9% for overhead.N15

Bibliography of Highway and Airport Literature

D *The Surveyor*
May 17

21. Soil Mechanics and Road Foundations. Discussion of D 7. Pp. 387-390.

May 24

22. Soil Mechanics and Road Foundations. Discussion of D 7. Pp. 407-408.

E *Engineering News-Record*
May 30

19. Rapid Field Test of Bituminous Mixes. By M. A. Ver Brugge. Pp. 51-52.

June 13

20. Pioneer Concrete Pavements Survive 35 Years of Hard Service. By Keyes C. Gaynor. Pp. 13-114.

J *American City*
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12. How to Patch and Resurface with Asphaltic Concrete. By W. H. Droege. Pp. 86-87.
13. Columbus, Ga., Selects Soil-Cement Paving. By J. M. Graddy. Pp. 100-101.
14. New Airport Lights for Large and Small Fields. By W. A. Pennow. Pp. 129-131.
15. Airport Plans of Davenport, Ia. By Arthur H. Lewis. Pp. 82-83.

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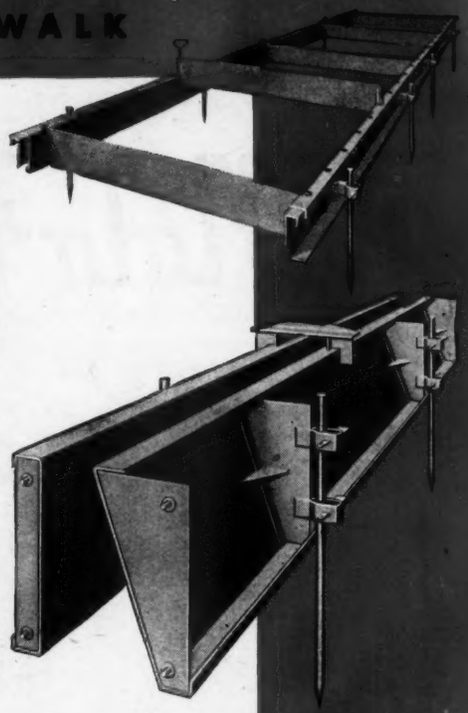

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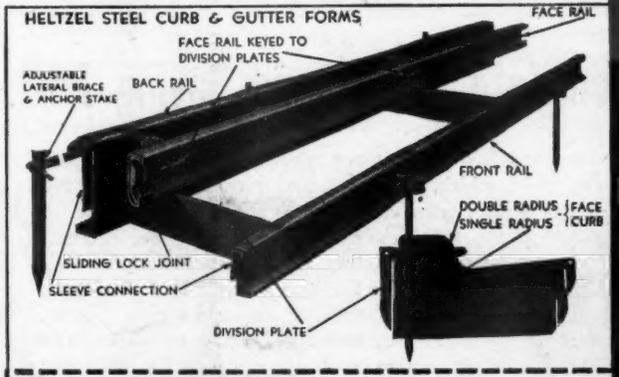

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L *Civil Engineering*
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6. What Can Be Done About Traffic Congestion? By Robert A. Mitchell. Pp. 260-262.

N *Roads and Streets*
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39. Million-Dollar Iowa Grading Job. By H. J. McKeever. Pp. 65-70.
40. Highway Departments Agree on New Truck Limits. P. 71.
41. High Production with Low Accident Rate on Wilkes-Barre-Scranton Airport. By H. K. Glidden. Pp. 74-78.
42. Engineering's Part in Eliminating the Highway Traffic Toll. Pp. 80-83.
43. Winter Costs Up 100% in Vermont Since 1936. P. 86.
44. Slide Control Maintenance in West Virginia. Pp. 90-92, 98.
45. Maintenance Costs Vary Greatly. Pp. 99, 122.

O *Roads and Bridges*
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30. Ste. Rose Bridge, World's Longest Continuous Welded. By J. S. Walsh. Pp. 40-50, 97.
31. Subways and Traffic Congestion. By C. A. Meadows. Pp. 51-53, 106.
32. Elimination of Accident Hazards. By J. Carl McMonagle. Pp. 54-56, 98.
33. Concrete Paving Design from Canadian Viewpoint. By J. M. Breen. Pp. 57-58, 114.
34. The Cost of Traffic Congestion in the City of Montreal. By DeGaspe Beaubien. Pp. 59-60, 102.
35. Methods and Degree of Compaction of Fills and Subgrades. By G. B. Williams. Pp. 61, 104.
36. Construction of Highway Fills in Swamps and Bogs. By Guillaume Piette. Pp. 62, 112.
37. Highway Construction in Peru. By Edgel C. Skinner. Pp. 63-68, 112.

P *Public Works*
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27. Ohio Uses Hot Mixed Asphalt for Surfacing, Salvage and New Construction. By Fred W. Kimble. Pp. 20-22, 32.
28. Asphalt Subsealing of Concrete Pavements in Mississippi Highways. By A. M. White. Pp. 24-26.
29. Tests of Thin Concrete Surfacing on Australian Highways. P. 28.

S *Construction Methods*
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4. Special Equipment Places 3-Foot Widening Strip Along Sides of Concrete Pavement. Pp. 94-96.

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5. Heavy Rollers for Soil Compaction. Pp. 100-102.

U *Public Roads*
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4. Longitudinal Cracking in Concrete Pavements. By Earl C. Sutherland. Pp. 207-219.
5. Behavior of Asphalts in Thin-Film Oven Test. By R. H. Lewis and W. J. Halstead. Pp. 220-226.

Z *Highways, Bridges and Aerodromes*

10. Mechanical Equipment: Principles of Use. By R. Gordon Hughes. Pp. 3-6, 10-15.

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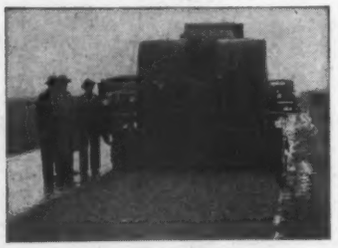

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Le Roi Company Announces New Cleveland Operations

C. W. Pendock, president, Le Roi Co., Milwaukee, Wisc., announces the formation of new manufacturing operations to be known as "The Cleveland Division." This division will produce a complete line of rock drills and related pneumatic equipment to serve the construction, mining and transportation industries, thus complementing the company's complete line of portable compressors. Russell R. Morgan, a former officer of the Cleveland Rock Drill Co., heads the Cleveland Division.

Paving Products.— A new 16-page Keystone catalog graphically lists and illustrates the company's complete line of paving joints, sealing compounds, concrete curing compounds and sewer joint compounds. Engineering designs and specifications are shown. Copies are available from Keystone Asphalt Products Company, 43 East Ohio Street, Chicago 11, Ill.

Columbia Chemical Division of Pittsburgh Plate Glass Co., has purchased the chlorine and caustic soda producing plant at Natrium, W. Va., from the RFC. The plant was built and operated by Columbia for the government during the war.

The H. B. Salter Mfg. Co., Marysville, O., has acquired the Glauber Brass Mfg. Co., of Kinsman, O. The Glauber plant, which covers 45,000 sq. ft., will continue the manufacture of brass products, for which it has long been nationally known.

A conservation bureau, headed by E. C. Wenger, has been organized by the Portland Cement Ass'n., to correlate technical information and assist concrete users in water supply, sewage disposal, flood control, drainage, irrigation and related fields.

Bulldozers.—Newcomers in the Caterpillar line of products, the 8S and No. 7S (straight-type) bulldozers, designed and built for exclusive use with Caterpillar Diesel D8 and D7 Tractors. The booklet (Form 9198) features the design, digging characteristics, visibility for operator, ease of mounting and dismounting, curved moldboard, reinforcing plates for pusher loading and to back up cutting edge, and blade pitch and tilting adjustments. Copies may be obtained from Caterpillar Tractor Co., Peoria 8, Ill.

The *120 Trencher* is described in a new booklet by Buckeye Traction Ditcher Co., Findlay, O. This is a boom type trencher which digs from 18″ to 48″ wide and to 11′6″ deep. Ask for Bulletin T-120.

A new folder by Littleford Bros., Inc., Cincinnati, O., features the utility *spray tank*, the *trail-o-roller* and a *heating kettle.*

An extraordinarily interesting booklet has been issued by Gardner-Denver Co., Quincy, Ill. There are few engineering data, but pictures from all over the world and narrative worth reading.

Dozer-Shovels are described in a new 24-page bulletin issued by Bucyrus-Erie Co., So. Milwaukee, Wis. This unit is a combined bulldozer and tractor-loader or shovel, easily changed from one to the other.

Gunite Concrete, what it is, characteristics, adaptability, and methods of use are described in a technical booklet issued by Gunite Concrete and Construction Co., 1301 Woodswether Road, Kansas City, Mo.

Rolagrip, an advanced means of coupling pipe, is described in a folder issued by Gustin-Bacon Mfg. Co., Kansas City, Mo. These couplings do not require any preparation of the pipe end, and are especially valuable on repair work, since odd lengths of pipe can be cut out and replaced without returning to the shop.

Nukemite, an *acid and alkali proof plastic coating* is described in a new bulletin by Nukem Prod. Corp., Buffalo, N. Y. This is a synthetic resin solution which can be applied with a brush or spray to form a continuous and impenetrable plastic film possessing extreme resistance to acid, alkali or other strong solutions and to fumes.

Four attractive and informative new bulletins on Heil bodies and hoists are available on request to The Heil Co., 3000 W. Montana St., Milwaukee 1, Wis. They are: BH-4534—*Heavy duty dump bodies* and twin cylinder hydraulic telescopic hoists; BH-4550—Twin arm *hoists for heavy duty* trucks; BH-4533—Twin arm *hoists and bodies for 1½ to 2½* ton trucks; and BH-4549—*Platform Conversion Hoists.* This company reports thirty different improvements in the design and construction of its arm type hydraulic hoists over its pre-war models.

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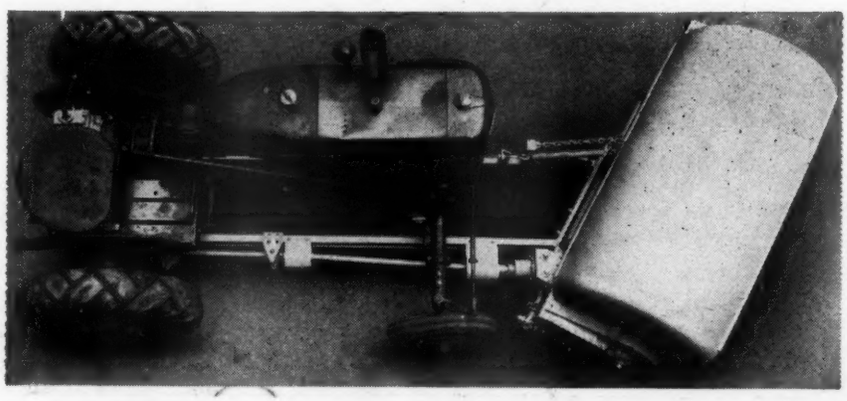


PUBLIC WORKS Equipment News

New Kwik-Mix Concrete Mixer

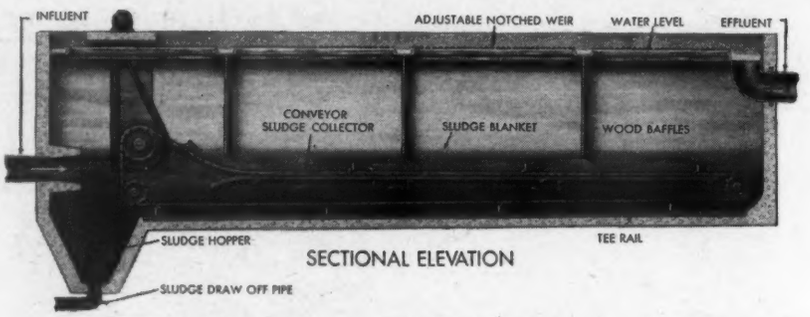
The new Kwik-Mix 11-S Dandie concrete mixer is illustrated and described in a new catalog just published by the Kwik-Mix Company, Port Washington, Wis., which contains 38 photographs and diagrams of the Kwik-Mix 11-cubic foot mixer.

Complete dimensions and condensed specifications are given for the 2-wheel end discharge models and for the 4-wheel 11-S which is available as either end or side discharge mixers.

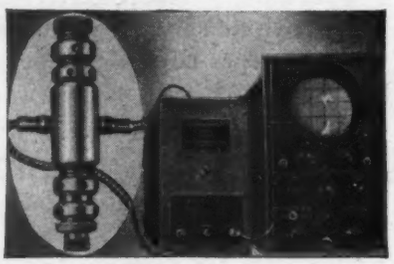
Particular emphasis is placed on the thorough re-mixing action of the Kwik-Mix 11-S Dandie and on its heavy duty construction. High strength steel is utilized at every point of strain. Because of its tilted flow-line discharge chute, the mixer is completely discharged in two revolutions of the drum or in 7 seconds. Charging time is cut, and shaking strains are reduced with a new selective skip shaker which shakes only after the skip is partly empty.

New Timber Truss Design Uses Less Material

A new type of timber truss, designed by Everett S. Lank, prominent timber engineer, uses less than 50% of the material usually required for the usual type of flat trusses. A Lank-Teco, a 50-ft. truss, designed to carry 40 lbs. per sq. ft. over a 16-ft. spacing, was tested to failure at the testing laboratory of the Timber Engineering Company. Prior to the failure test, the truss had carried full design load for over six months and had a total deflection of less than 1". At twice design load the truss had a deflection of about 2". (The original camber being 2", the bottom chord of the truss was about level at this point.) Failure came in shearing out at the splice in the bottom chord at a load of over 2¼ times design load. At this time the truss was carrying over 36 tons of sand. In addition to the excellent strength performance of this truss, it is one of the most economical wood trusses ever designed. Teco connectors are used throughout.



Chain belt new type sludge thickener.



This is the Pressuregraph, used to indicate pump or engine performance, which was described on p. 59 of the June issue.

A New Sludge Thickener

Chain Belt Company, Milwaukee 4, Wis., manufactures a new vertical flow, slurry blanket type of the thickener known as the "Rex Verti-Flo Thickener." This unit is designed to deliver highly clarified effluents with relatively low detention periods when handling certain types of solids. It employs a unique cellular construction obtained by dividing a conventional sedimentation basin with weirs and baffles. Extremely long weir length is obtained with this design. The adjustable weirs allow close regulation of flow distribution among the cells.

Sludge collectors concentrate the sludge at the influent end of the tank and maintain a fluid sludge blanket in the zone of flow immediately below the baffles. Continuous operation of the conveyor sludge remover provides a constant recirculation of sludge to the influent end of the basin. Existing basins may be remodeled to provide greater capacity, or improved results, by using the Rex Verti-Flo principle.

Durham, N. C., has two International "A" tractors and an ID-6 wheel tractor. The illustrations show the A tractors in use: One, with a mower on it, is smoothing a shoulder with an 8-ft. wooden drag; the other is equipped with a broom and is shown sweeping a gutter, but is also used for sweeping in surface treatment and for general street cleaning.

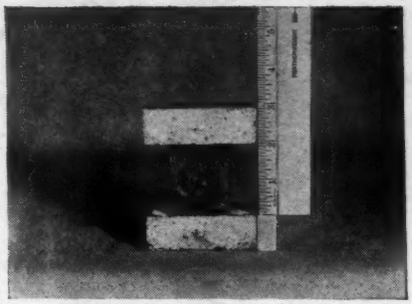
New Chain Belt End-Discharge 3½S Mixer

Chain Belt Company announces the manufacture of a new Rex end-discharge 3½S tilting mixer. This new mixer weighs 150 pounds less than the former side discharge model, making it considerably easier to hitch and spot. Its wheel tread has been increased to 62 inches. . . . about the same as that of an automobile. A lower center of gravity is obtained by cradling the mixer body between the wheels, resulting in faster and safer towing. Additional details can be had by writing Chain Belt Company, 1600 West Bruce Street, Milwaukee 4, Wisconsin.

Tubing Fitting Eliminates End Preparation

Flexigrip tubing fittings eliminate end preparation or soldering of tubing but produce a strong, leakproof and flexible joint. These are made in stand-

ard sizes from ⅛" to 1½" O.D., and consist of four parts—the body, a gripping ring, synthetic rubber gasket and nut. To attach the fitting, the nut (with gasket and ring inside) is slipped over any plain-end tube, cut to desired length. The tubing end is inserted into the body as far as it will go and the nut tightened. Tightening the nut compresses the ring into a tight grip and moulds the gasket around the ring for a leakproof seal that is so flexible it will withstand unusual vibration or impulse. These fittings are made by Gustin-Bacon Mfg. Co., Kansas City, Mo.



Careylastic (at 0° F) extended 100% greater than required by federal specifications. A product of Philip Carey Mfg. Co.

New Caterpillar Bulldozers

Bulldozers, by Caterpillar, are described in a folder of the usual "Cat" quality. These new additions to the Caterpillar line are the 8A and the 7A (angling type), which are designed for the D8 and D7 tractors.

Diesel-Electric Crushing and Screening Plant by Pioneer

First in a new line of portable semi-electric powered duplex crushing and screening plants is the No. 46-VE announced by Pioneer Engineering Works. In this plant, the screen and conveyors

New Pioneer duplex powered by diesel-electric

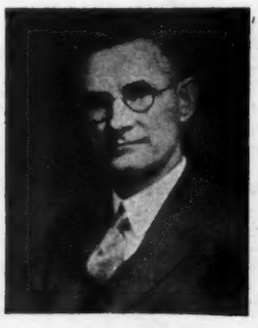
are driven by electric motors from power supplied by a diesel-electric plant. The roll crusher is driven by V-belts from the jaw crusher, which in turn is driven by flat belt to the diesel motor. A clutch provides for starting and stopping the crusher without interrupting the diesel drive to the generator.

Through the use of electric motor drives, snake belt drives, numerous shafts, chains and sprockets, beveled gears and pinions and swivel drives have been eliminated. The operating height of the plant has been lowered from 19¼ feet to approximately 14½ feet; and in transit the plant has only an overall height of 12½ feet. Moving weight is ony 64,000 pounds. Full details from Pioneer Engineering Works, Minneapolis 13, Minn.

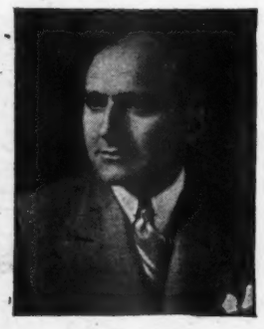
Pittchlor—A New High Test Hypochlorite

A new high-test calcium hypochlorite, containing a minimum of 70 percent available chlorine, is now available for civilian uses, according to the Columbia Chemical Division of the Pittsburgh Plate Glass Company. Now marketed under the trade name "Pittchlor," the product previously had been requisitioned by the armed forces in very large quantities as a bleach, germicide and disinfectant. It has special advantages for the chlorination of water suppiles up to approximately 500,000 gallons per day, or where the daily requirement of available chlorine is approximately one pound.

S. B. APPLEBAUM



N. E. BRICE



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For the Engineer's Library

Measurement, Control and Chemical Treatment of Sewage and Sludge.—This text states that it aims "to include material of real value to engineers and others engaged on sewage treatment problems for both large and small communities." It accomplishes this aim exceedingly well. A sewage plant diagram shows locations where meters and controls are needed. There follows a section on selection of metering instruments; another on measuring flow in partly filled pipes and open channels; and others on chemical feeding and continuous conditioning of sludge. 20 p., ill. Builders-Providence, Codding St., Providence, R. I.

Better Highway Maintenance.—Full details, construction features and specifications, with descriptions of attachments and operation of the Speedmaster Melting Kettle. Catalog 661. Hauck Mfg. Co., 124-136 Tenth St., Brooklyn 15, N. Y.

Pipe Lining.—An excellent booklet, which in describing a process for lining large water mains, gives valuable data on carrying capacity of mains, and the losses that accrue over a period of years. The sections are: Historical, Economics, and Operation. 12 p., ill. Preload Corp., 420 Lexington Ave., N. Y. 17, N. Y.

Products for Water Works.—Johns-Manville has compiled and has ready for distribution a two-part 72-page booklet "Products for the Water Works Industry." Part one contains over 100 photographs of actual installations of the many Johns-Manville asbestos products in treatment plants and water works systems throughout the country. Each photograph is identified and located by name in the captions. Typical of the many applications included are: Insulation of piping in pumping stations and boiler rooms; insulation of water mains to prevent freezing; packings for fire hydrants, valves, centrifugal pumps, etc.; gasketing for steam lines and water purification and re-circulation lines; Asbestos-Ebony for control tables in filter plants and instrument panels in pumping stations; friction materials for well drilling rigs; corrugated Transite for reservoir covers, storage sheds, and other types of structures; asphalt tile flooring for offices and laboratories; roofing and shingles for water treatment structures and other buildings; and Transite pressure pipe for supply lines and distribution mains; also Transite pipe for aeration, well casings and screens, and for filter underdrain systems. Part two is a catalog containing descriptions of the illustrated Johns-Manville products with further information regarding their use. The book is 8½ x 11 in size. Its designation number is TR-39A. Copies may be obtained by writing Johns-Manville, Box 290, New York 16, N. Y.

Road Construction.—In a new booklet, "Motor Graders," published by Caterpillar Tractor Co., Peoria, 8, Illinois, the story of methods utilized in the many and varied phases of highway construction and maintenance is told and graphically illustrated with the versatility of the all-purpose motor grader illuminated in word and picture. The exacting demands of surface maintenance, modernizing, ditching, scarifying, grading, bank sloping, breaking, excavating, drifting in normal conditions are listed and such winter chores as "winterizing" and snow plowing are depicted. In addition, the machinery's utility in airport construction and city expansion and improvement are cataloged. Copies of the booklet may be obtained from Caterpillar.

Waterproofing Specification Book.—Book "A," a new specification book of Truscon waterproofings, dampproofings and concrete specialties, is divided into 3 sections, namely: "Waterproofings," including integral waterproofing and iron waterproofing; "Dampproofings," including clear dampproofing and bitumious dampproofings; "Miscellaneous," consisting of transparent membrane method for curing concrete, swimming pool coatings, paint for damp walls, shrink proof mortar, admixture for bedding machinery, etc. Copies from Truscon Laboratories of Detroit, Michigan.

Graver Sludge Blanket Type Reactivator. — A complete description and operating explanation of the Graver Sludge Blanket Type Reactivator is contained in a new 8-page illustrated booklet which explains the principles and advantages of upward sludge filtration and describes its adaptability to the effective treatment of both industrial and municipal water supplies. Charts, flow diagrams, and cut-away drawings show clearly how this equipment can soften and clarify raw water, materially reduce reaction time, and provide a treated water that, in many cases, is suitable for process use without further treatment. A copy may be obtained by writing Graver Tank & Mfg. Co., Inc., 332 South Michigan Avenue, Chicago, Illinois.

Rotary Positive Blowers.—A new bulletin on this subject by Roots-Connersville Blower Co., Connersville, Ind., describes their blower units, which are built in 5 to 50,000 cfm. capacities, for pressures to 30 lbs. Considerable worthwhile engineering data for the man interested in handling air.

Sanitation Equipment.—The complete line of Rex sanitation and liquid clarification equipment is presented in a new 44-page book; pictures, drawings, and diagrams are used profusely. The products illustrated and described include conveyor sludge collectors and Tow-Bro sludge removers, grit collectors and washers, Verti-Flo thickeners, skimmers, Aero-filters, Floctrol, rapid mixers, gravity waste water-oil separa-

tors, and water screens. Request bulletin No. 46-3, from Chain Belt Company, 1600 West Bruce Street, Wilwaukee 4, Wisc.

Aeration Tanks and Diffuser Media in Activated Sludge.—This is a new edition of a well-known, authoritative and much used text. It contains brief descriptions of aeration tanks for sewage treatment, diffuser plate containers, and diffuser plates, in a number of sewage treatment plants, with comparative data on design and operation; also methods of cleaning diffuser plates. 30 p., ill. Filtros, Inc., East Rochester, N. Y.

Sheet Piling Data.—A good brief reference and instruction text on steel sheet piling. Published by Caine Steel Co., 1820 No. Central Ave., Chicago 39,

Ill., this booklet contains diagrams, tables, dimensions and weights, and shows how to use sheet piling on sewer construction, bulkheads, retaining walls, dams and flood protection structures. 20 p., ill.

Highway Joints, Strips, Curing and Sealing.—Keystone Asphalt Products Co., 43 East Ohio St., Chicago 11, Ill., has made a survey covering practices of 46 State highway departments in regard to expansion joint layout and design, contraction joints, center strips, joint sealing compounds and curing methods. These valuable data are summarized and compiled in a report which which will be sent on request to R. A. Ornberg, at the above address.

"Pressure Distributors in a Nut Shell" is an excellent brief presentation of the Littleford "Spraymaster" pressure distributor. Littleford Bros., Inc., 452 East Pearl St., Cincinnati, Ohio.

Axial flow pumps in capacities up to 100,000 gpm and for heads to 50′ are described in an excellent new bulletin, No. G845, issued by Economy Pumps, Hamilton, Ohio.

PERSONAL NEWS

George C. Bunker has reopened his consulting engineering office in Panama, R. P. (Apartado No. 1423). During the past nine and a half years Mr. Bunker served as consulting engineer to the National Ministry of Public Works and the National Institute of Sanitary Works, Caracas, Venezuela, S. A., and specialized in the development and purification of water supplies.

Dr. Foster Dee Snell, president of Foster D. Snell, Inc., Consulting Chemists and Engineers, 305 Washington St., Brooklyn 1, N. Y., has been elected president of the American Institute of Chemists.

L. O. McLean has been appointed sales manager of the General Excavator Co., Marion, O., succeeding Don B. Smith.

Charles A. Mayer has been appointed assistant engineer, New York Office, of the Asphalt Institute, to act as administrative engineering assistant to Bernard Gray, general manager and chief engineer.

Russell B. Moore and Mark B. Owen, operating as Moore and Owen, Consulting Engineers, are engaged in a variety of sanitary engineering work in and around Indiana. A new chemical laboratory, equipped to make complete water and sewage analyses has been completed and is available to all engineers in need of such service. Moore and Owen are located at 1456 No. Delaware St., Indianapolis, Ind.

Education, Research and College

Fellowships to train 125 sanitary engineers and physicians in public health have been approved by the National Foundation for Infantile Paralysis. These fellowships provide one year of graduate study and are available for the academic years beginning in the falls of 1946 and 1947, and are for men and women under 45. Also, they are for newcomers in the public health field and are not open to employees of state or local health departments. For details, write *at once* to the Surgeon General, U. S. Public Health Service, Attention Public Health Training, Washington, D. C.

The National Lime Ass'n. has established a fellowship in the Department of Sewage and Waste Treatment, Rutgers University, under the direction of Dr. Willem Rudolfs. R. P. Logan will be in charge of the work and R. Y. LeVine of the laboratory work. The program will center on the utilization of various types of lime products in the treatment of liquid wastes.

The Johns Hopkins University, Baltimore, Md., has issued a bulletin describing the sanitary engineering courses to be offered this fall. Provision is made for a one-year course leading to the degree of Master of Science in Sanitary Engineering. Write Abel Wolman, Professor of Sanitary Engineering, for details of this course and of the one leading to a doctorate in sanitary engineering.

Meetings and Associations

The 1946 Conference of the Municipal Electric Utilities Association will be held at the Mark Twain Hotel, Elmira, N. Y., on Sept. 25-27. T. J. McKee, Jamestown, N. Y., is secretary.

The Georgia Water and Sewage School will be held at Georgia Tech., Atlanta, Ga., Sept. 16-18. Van P. Enloe, RFD No. 5, Box 363, Atlanta, Ga., is secretary and will furnish desired information.

The California Section, AWWA, will hold its convention in San Francisco, Calif., Oct. 23-25, at the Hotel Whitcomb and the Civic Auditorium. Ray L. Derby, PO Box 3669, Terminal Annex, Los Angeles 54, Calif., is secretary-treasurer.

The 19th meeting of the Federation of Sewage Works Associations will be held at the Royal York Hotel, Toronto, Canada, Oct. 7-9. Full information on the technical and social program can be obtained from the secretary, W. H. Wisely, 325 Illinois Building, Champaign, Ill.

The New England Water Works Ass'n. Nominating Committee has submitted the following list of nominees: President, Arthur L. Shaw; vice-president, Arthur C. King; director, Philip J. Holton, Jr.; and treasurer, William P. Melley.

JOBS FOR ENGINEERS

The Newark College of Engineering, Newark, N. J., wants a sanitary engineer to teach sanitary and some civil engineering subjects. "Salary attractive on basis of experience." Write Prof. William LaLonde, Jr.

There is a vacancy for an assistant professor at the University of Michigan. Write Earnest Boyce, Professor of Municipal and Sanitary Engineering, University of Michigan, Ann Arbor, Mich.

An instructor in Sanitary Engineering is needed by the University of Illinois. The requirements are: Graduation from sanitary engineering curriculum; high scholarship; and 3 or 4 years of experience, either civilian or military. Salary range $3000 to $3500, depend-

(Continued on page 74)

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2. Jaeger air compressors, made in sizes 60 to 500 cu. ft.; trailer, truck, tractor and stationary mounted, gas, Diesel and electric power. Catalog and data. The Jaeger Machine Co., 400 Dublin Av., Columbus 16, O.

Bins and Batching Plants

11. Good illustrations and useful data on all types of Heltzel Highway Bins, for truck mixer charging, bulk cement plants, enclosed bucket elevators, belt conveyors, etc. Heltzel Steel Form & Iron Co., Warren, O.

Resurfacing Plants

15. Portable Bituminous Mixers in 6 to 14 ft. sizes for resurfacing and maintenance. Issued by The Jaeger Machine Co., 400 Dublin Ave., Columbus 16, Ohio.

16. Moto-paver is a new type self-contained travelling asphalt plant having a capacity of 100 to 120 tons per hour. A novel spreading and laying device permits quick change to various road widths and crown conditions and thicknesses. Write Hetherington & Berner, 729 Kentucky Ave., Indianapolis 7, Ind. for Bulletin MP46 which gives full descriptions and specifications.

Concrete, Early Strength

38. 64-page manual tells how to speed concreting, to secure high early strength and greater workability at temperatures either below or above freezing. 60 photos, charts, graphs and tables. Calcium Chloride Assn., Penobscot Building, Detroit 26, Mich.

Concrete, More Durable

50. How cement dispersion assures improved concrete with impressive economies in initial construction costs and maintenance costs. Manual from The Master Bufilders Co., 7016 Euclid Ave., Cleveland 3, Ohio.

Drainage Products

70. Standard corrugated pipe, perforated pipe and MULTI-PLATE pipe and arches — for culverts, sewers, subdrains, cattlepasses and other uses. 48-page booklet, No. 12. Armco Drainage Products Association, Middletown, Ohio.

72. New data on clay pipe is contained in literature offered by National Clay Pipe Manufacturers Inc. Address them at 111 W. Washington St., Chicago 2, Ill.

Generators

80. Two portable generators, one for AC and the other for DC current are described in new bulletin issued by Homelite Corp., Port Chester, N. Y. Commonly used for operating electrical equipment in planes, tanks and trucks, or to charge batteries or to supplement batteries for starting main engines, etc.

Graders, Patrol

96. The Austin-Western 99M Power Grader with its powerful all wheel drive handles difficult jobs with economy and efficiency; and does better work on grading, ditching, scarifying, snow ploughing, loading, mixing, bulldozing, shoulder trenching and backsloping. Write for Bulletin 1946. Austin-Western Co., Aurora, Ill.

Joints, Expansion

102. Para-Plastic hot-poured rubber joint sealing compounds and Asphalt, Fibre, Cork, Cork-Rubber, Sponge Rubber and Waterstop expansion joints are described and illustrated. Write Servicised Products Corporation, 6051 W. 65th St., Chicago 38, for a copy.

Memorial Plaques

106. Honor rolls, memorials, sculptured bas-reliefs, plaques, tablets, name plates and letters of bronze are illustrated and described in folder sent on request to Architectural Bronze & Aluminum Corp., 2342 W. Belmont Ave., Chicago 18, Ill.

Mud-Jack Method

107. How the Mud-Jack Method for raising concrete curb, gutter, walls and streets solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities—a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee 10, Wis.

Paving Breakers

110. Powerful self-contained gasoline hammers illustrated. Used as paving breakers and spike drivers. Easily portable, economical. Write Syntron Co., Box 220, Homer City, Pa.

Paving Materials, Bituminous

111. New "Tarvia Manual" is packed with useful data on how to build and maintain roads with Tarvia. Each step is illustrated with excellent action pictures, 64 pp. 103 illus. Write to The Barrett Div., 40 Rector St., New York 6, N. Y.

Piling, Steel

112. Illustrated descriptions of both standard and interlock corrugated steel sheet piling of minimum weight, maximum strength, ease of handling with methods of installation are contained in a booklet. If you have a job involving piling write Caine Steel Co., 1820 N. Central Ave., Chicago 39, Ill.

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117. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

121. "Sure prime" portable pumps—the full line—describing certain special features for all-weather service, are described in Catalog P-45, to be had by writing The Jaeger Machine Co., Columbus, Ohio.

122. Pump Bulletin L-501 just out, gives latest illustrated information on Homelite gasoline engine driven portable pumps. Write Homelite Corp., Port Chester, N. Y.

Road Building and Maintenance

126. Two and Four Wheel Scrapers, Bulldozers, Tamping Rollers, Winches, Hoists and Repair Towers are subject of special bulletins issued by Gar Wood Industries, 7924 Riopelle St., Detroit 11, Mich.

128. Two powerful Galion motor graders designed to answer every requirement for more speed in road, airport, dam and housing construction work are fully described in a folder illustrated with many action pictures. Issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

130. BG Maintainer, a powerful speedy, low-priced machine for light road maintenance. Write for folder, Huber Mfg. Co., Marion, Ohio.

Rollers

141. Three-Wheel and Tandem Rollers, 5 to 8-ton and 10 & 12 ton sizes: also variable weight tandem roller for new highway surfacing and old road conditioning. Huber Mfg. Co., Marion Ohio.

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150. "High-Service, Low Cost Roads" sets forth the principles and advantages of road surface stabilization with calcium chloride. Complete, interesting and well illustrated, 34 pages. Sent by Solvay Sales Corp., 40 Rector St., New York 6, N. Y.

152. Complete information dealing with Calcium Chloride Stabilized Roads. Contains many charts, tables and useful information. Write Columbia Chemical Div., Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh 19, Pa.

154. "Soil Stabilization with Tarvia" —An illustrated booklet describing the steps in the stabilization of roadway soil with Tarvia will be mailed on request by The Barrett Division, 40 Rector St., New York 6, N. Y.

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187. Mix-in Place Roadbuilders, Bituminous Pavers, Concrete Bituminous Finishers. Adjustable Spreaders, Forms, etc. —4 complete catalogs in one cover, issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus 16, Ohio.

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190. International Diesel Tractors are described and many uses mentioned in 48-page catalog. Write International Harvester Co., 180 North Michigan Ave., Chicago 1, Ill.

192. Little Giant Tractor Sweepers for streets are described in illustrated bulletin. Especially designed to meet the needs of smaller cities and towns. Address: Little Giant Products, Inc., 1554 N. Adams St., Peoria 3, Ill.

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354. Ice Prevention on Highways, Streets, and Airport Runways with Sterling "Auger Action" Rock Salt. An illustrated bulletin issued by International Salt Co., Inc., Scranton, Pa.

Sanitary Engineering

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357. Automatic Air Release Valves for water, sewage and industrial uses are described and illustrated in new catalog issued by Simplex Valve & Meter Co., 6750 Upland St., Philadelphia 42, Pa.

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360. "Methods of Analyzing Water for Municipal and Industrial Use" is an excellent 94 page booklet with many useful tables and formulas. Sent on request by Solvay Sales Corp., 40 Rector St., New York 6, N. Y.

Activation and Aeration

367. A valuable booklet on porous diffuser plates and tubes for sewage treatment plants. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability, 20 pp. illustrated. Sent on request to Norton Company, Worcester 6, Mass.

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420. Le Roi engine-generator units for operating on "no cost" sewage gas are fully described and illustrated in new bulletins now available. Address Le Roi Co., 1726 S. 68th St., Milwaukee 14, Wis.

Laboratory Equipment

423. pH and Chlorine Control. A discussion of pH control and description of comparators, chlorimeters and similar devices. An 80-page booklet, W. A. Taylor & Co., 7301 York Road, Baltimore 4, Md.

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474. Technical pub. No. 207 issued by Wallace & Tiernan Co., Inc., Newark 1, N. J., describes in detail taste and odor control of water with BREAK-POINT Chlorination. Sent free to any operator requesting it.

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(Continued from page 70)

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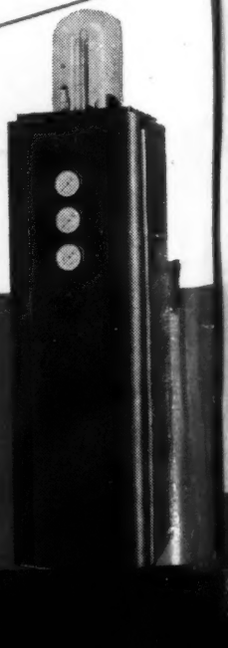

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